THE

TROPICAL AGRICULTURIST

VOL. LXII. PERADENIYA, MARCH, 1924. **No. 3.**

NEW AGRICULTURAL PUBLICATIONS.

We have received the first numbers of the EMPIRE COTTON GROWING REVIEW which is to be issued quarterly, and of TROPICAL AGRICULTURE which is to be published monthly and consider that Editorial reference should be made to them.

The Empire Cotton Growing Review is the Journal of the Empire Cotton Growing Corporation, the history of which is briefly set out in the first number. The earliest endeavours to stimulate the Empire's production of cotton were made in 1902 when the Manchester and Lancashire Chambers of Commerce together with the leading West African merchants of Liverpool decided upon the inauguration of the British Cotton Growing Association. This Association aimed at the greater production of cotton within the Empire and immense patriotic exertions were made to stimulate cotton growing. In the process of time, this Association realized that the support of Government was necessary and in 1917 a Committee representing Government Departments and the cotton trade was appointed to consider the matter in its fullest details.

As the result of the deliberations of this Committee, which terminated at the end of 1919, the British Empire Cotton Growing Corporation was formed under Royal Charter. Its financial resources are assured as they are derived from a capital contribution of nearly £1,000,000 made by the Imperial Government and by a levy, which was made compulsory on all cotton spinners in July 1923, of six pence per standard bale of cotton imported into the United Kingdom.

This Corporation is becoming the Central Bureau of Information for the cotton industry and has expert advisers in Australia, South Africa, the Soudan and other African possessions of the Empire.

Its Journal has been started with a view to collecting and disseminating knowledge of all matters of interest to scientific officers concerned with cotton and to cotton growers.

It is under the able editorship of DR. J. C. WILLIS, who was for many years the respected editor of the TROPICAL AGRICULTURIST.

The new monthly, TROPICAL AGRICULTURE, is the Journal of the Imperial College of Tropical Agriculture which has recently been started in Trinidad, British West Indies, and will replace the AGRICULTURAL NEWS which was formerly issued fortnightly by the Imperial Department of Agriculture for the West Indies.

The Imperial College of Tropical Agriculture was formally opened in 1922 and provides for a three years' Diploma Course, postgraduate studies and for research. The foundation stone for its buildings has just been laid.

The Diploma course of this College is designed to afford a sound basis of education in the agriculture of the Tropics and special attention is given to the methods, handling and marketing of crops, to the management of estates and to the handling of labour.

Facilities which have been found to be so advantageous to agriculturists in temperate regions are being afforded for those who propose to work with tropical crops and the courses are intended to form a ground work for study on the part of those expecting to engage in general estate work and to give a training for those who wish to secure appointments in the various colonial Agricultural Departments.

This College has evolved out of the Imperial Department of Agriculture which has done much solid work for the West Indies and should have a good future before it. Its Journal is welcomed amongst agricultural literature and the various articles in its first number are worthy of close study.

The addition of the above publications to the serials dealing with Tropical Agriculture marks another considerable advance and it is expected that they will have much future usefulness before them.

TEA.

SOME OBSERVATIONS ON MICRO-ORGANISMS ASSOCIATED WITH TEA FERMENTATION.

A. C. TUNSTALL, B.Sc.,

Mycologist, Indian Tea Association.

At the suggestion of the Chief Scientific Officer the writer commenced an investigation of the micro-organisms found in fermenting tea leaf. These investigations have been continued for some time at intervals as the work on tea diseases permitted.

Considerable research on this subject has been carried out in Java and the results of the Java scientists have been published from time to time in the MEDEDEELINGEN VAN HET PROEFSTATION VOOR THEE. They discovered that there were a number of micro-organisms always present in fermenting tea. They isolated some of these organisms and came to the conclusion that moulds and bacteria were harmful while the yeasts, while not being harmful, did no apparent good.

As the conditions in Java differ considerably from those of the tea districts of North-East India it was decided to disregard the conclusions arrived at in Java and to carry on the investigation with an open mind.

A start was made by isolating the various organisms present in fermenting leaf and growing them in pure culture. A number of bacteria and various yeasts were found. Few moulds were present.

In order to test the effect of individual organisms an attempt was made to sterilise tea leaf. It was obviously undesirable to sterilise the leaf by heat as by so doing the chemical composition would be changed. Various chemical substances were experimented with including Chloroform, Chlorogen, Formalin, Hydrogen peroxide and Corrosive sublimate, but in every case where complete sterilisation was obtained the nature of the leaf was so altered as to be useless for our purposes.

It was therefore decided to carry out the inoculation experiments without sterilisation, using such overwhelming numbers of the organisms concerned that the effect of the organisms already present would be entirely masked. The results of the preliminary experiments showed that the bacteria isolated produced undesirable taints while the yeasts generally produced a desirable aroma, and in some cases a difference in taste. It was further noticed that the aroma produced by the various yeasts differed considerably, but none were undesirable. In the course of the culture experiments it was noticed that some tea medium had been accidentally infected with black mould *(Aspergillus niger)*. Reference to scientific literature on the subject showed that this mould was known to produce an enzyme when grown on ordinary oak-tannin solutions. Further experiment showed that the mould produced an enzyme when growing on tea-tannin, and a quantity of this enzyme was isolated.

Some experiments were then carried out to ascertain the effect of the mould-enzyme on tea leaf in which the enzymes naturally present had been disorganised by heat. From our observations it would appear that the mould-enzyme brought about similar changes in the leaf as that produced by withering, *i.e.*, the rawness was changed to pungency and the green colour of the infusion to a golden-yellow. No brown colour characteristic of fermented leaf was noticed even after 21 hours. The enzymes produced in the leaf during withering and those produced by various yeasts were also isolated. Experiments with these seemed to indicate that the aroma of fermenting tea was due to the action of yeast and that the aroma was not observed unless the leaf had been withered or the tea-enzyme or the mould-enzyme were added. At this stage further experiments on these lines were postponed as time could not be spared to continue them.

Experiments were made to ascertain the micro-organisms present on fresh leaf, withered leaf, fermenting leaf, at the beginning and end of fermentation, and from the various machines, floors, etc., with which leaf comes into contact during the manufacture. It was found that yeasts predominated on the leaf, and that there was a ready increase of the number of yeast cells present as the manufacture proceeded until the maximum was reached when fermentation was completed. The rollers, sifters, fermenting-floors, etc., contrary to expectation, contained very few years, but often many bacteria.

Some of the bacteria isolated from fermenting rooms were found to give characteristic taints to the tea. One was responsible for a taint resembling that produced by over-firing.

Tea juice expressed during the rolling was found to contain a collection of organisms representative of those found on the leaf. Samples of tea-juice were obtained from many gardens and pure cultures prepared of the yeasts present therein. When sufficient quantities of pure yeasts were available tests were made by inoculating the leaf at various factories. Samples of the dried tea manufactured with and without the addition of pure yeasts were sent to leading tea tasters for report. It was found necessary to inoculate each roll of leaf as the yeasts did not propagate themselves on the fermenting-floors. Inoculation of the fermenting-floors was therefore useless.

At first it was noticed that the yeast-treated tea was frequently less brisk than the corresponding untreated tea. It was then found that the yeast-treated tea often fermented more rapidly. It was also noticed that the temperature of this tea rose more rapidly during fermentation than the other tea. Careful temperature observations were made at short intervals and it was found that the rise in temperature in both followed a characteristic curve during fermentation. It was also found that by spreading the leaf more thinly on the fermenting-floors the temperature of the yeasted tea could be kept down. When this was done the time of fermentation of the yeasted and unyeasted tea was approximately the same. It was also noticed that in many cases by spreading unyeasted leaf thicker and thus raising the temperature the time of fermentation was shortened. If, however, the leaf was pressed down so as to exclude air the temperature did not rise and the time of fermentation was lengthened considerably. When air was all

excluded by placing the leaf in an atmosphere of carbon dioxide the colour of the leaf did not change even after 24 hours. The aroma of the yeasted samples developed satisfactorily even under these conditions. In this connection experiments were made to ascertain whether the yeast destroyed the tannin. Leaf, treated with yeast and without yeast, was packed tightly into a number of glass tubes immediately after rolling and sealed up with wax. The tubes were kept at a constant temperature. Tannin estimations were made at intervals by the Chemical Department. No loss in tannin was noted in either the yeasted or unyeasted leaf in 24 hours. Some of the leaf from the tubes was then exposed to air and the loss in tannin estimated. There was a steady loss in tannin in both cases comparable with that normally lost during fermentation, but the yeasted tea fermented more rapidly.

A sterile solution containing pure tannin isolated from tea leaf by the Chemical Department was inoculated with yeast. No loss in tannin was observed even after a long period.

It would seem therefore that the yeast does not act directly on the tannin. The aroma produced by fermenting leaf varies from garden to garden and it is found possible by the use of yeast obtained from a particular factory to reproduce the aroma characteristic of the fermenting leaf in that factory in another factory, on a different class of leaf, in another district.

In many cases at the commencement of the experiments the aroma obtained in the fermenting room was not retained after drying. By improvements in the methods of cultivating the yeast it was found possible to obtain better results and the aroma was retained by the tea after drying,

Not only has it been found possible to change the aroma on a tea, but also to change the flavour.

At first it was suggested that the improvement in the treated tea would go off on keeping, but subsequent experiments have proved that the results are permanent.

Every planter knows that the quality of the tea varies with the time of the year. Observations of the micro-organisms present on the leaf at different times of the year show that the quantity of yeast on the fresh leaf is at its maximum when the best quality teas are being made. It has also been discovered that the yeast present when the best quality is being obtained is more active than that found at other times of the year. Yeast has been isolated from leaf on a number of gardens when the best quality was being made. The yeast cultures were stored for the time being and when the quality was no longer apparent the leaf was artificially inoculated with these yeasts with beneficial results. So far it has not been found possible to improve the flavour of the tea when first class tea is being made. It was found that yeast cells were naturally present in large numbers at that time and the addition of pure cultures of yeast had no apparent effect.

It is interesting to note that in growing the cultures of yeast from a number of gardens the individual selections showed a marked preference for culture medium prepared from tea leaf or tea-juice obtained from the garden whence they came. In the case of one yeast this was noticed after the yeast had been grown on tea medium obtained from other gardens for over a year.

It must not be assumed that by the use of pure yeasts it is possible to make Darjeeling tea in districts less favourably situated. Flavour and aroma alone are not the criterion of price. The yeast undoubtedly influences

flavour and aroma, but it cannot put pungency and strength into leaf which does not possess it already, neither can it alter the appearance of a tea. So far it has not been possible to obtain anything approaching the amount of flavour present in a first class Darjeeling or Upper Assam tea on teas of other districts.

The addition of pure cultures of yeast does not add anything to the leaf. The yeast is only able to act on the substances present in the leaf. It is merely an agent which is able under proper management to make the most of the substances on which it works.

Our experiments have shown that in many cases the use of pure cultures of yeast has improved the tea, but much more work is required to render it possible to get the results in all cases.

The writer has avoided reference to the technical details of the experiments as they are beyond the scope of this article. Over 3,000 pure cultures have been made in the course of the investigation and the work is by no means complete. A scientific study of the properties of the various yeasts so far isolated is being continued systematically and considerable improvement on the results so far obtained may be confidently expected.

In conclusion I should like to take this opportunity of thanking the managers and the tea tasters who are so kindly co-operating in this work.

SUMMARY.

1. Certain micro-organisms influence the flavour and aroma during fermentation.

2. Under certain circumstances it is possible to improve the aroma and flavour of tea by the use of pure yeasts in fermentation.

3. The yeasts are present on the fresh leaf and increase during withering and fermentation.

4. In the cases investigated, improved flavour and aroma are associated with increased numbers of the yeast cells naturally present on the leaf.

5. The organisms found on fermenting floors, rollers, etc., are usually undesirable.—QR. JOURN. OF SCI. DEPT. OF INDIAN TEA ASSN., PT. IV., 1923.

RIPENING OF TEA SEED.

The following extract is taken from the Report of the Curator, Hakgala Botanic Gardens, for the months of November and December, 1923 :—

With regard to the time taken for tea seed to ripen, the following table shows the results obtained :—

Bush	Flower Labelled	Fruit Ripened	Period
A.	1-12-22	14-11-23	349 days or 11½ months
B.	8-2-23	22-11-23	275 ,, 9 ,,
C.	18-2-23	10-11-23	273 ,, 9 ,,
E.	18-1-23	5-10-23	265 ,, 8¾ ,,
F.	18-2-23	10-11-23	273 ,, 9 ,,
H.	6-4-23	20-11-23	210 ,, 7 ,,

RUBBER.

SOME NOTES ON TAPPING SYSTEMS FROM THE POINT OF VIEW OF LATEX PRODUCTION.

E. BENDIXSEN.

INTRODUCTION.

The rubber content in latex of untapped Hevea trees varies from 35 to 60 %, and is seldom under 45 %. The content is almost constant for the individual tree. It may, therefore, be assumed that after a group of latex vessels has been fully developed from the cambium, the production of rubber is reduced to the quantity necessary to maintain equilibrium in the system. Consequently when a Hevea tree is not tapped, only very little energy is spent on production of latex, and the tree can use its assimilated products for the development of its roots, trunk and crown.

The tapping cut, followed by a flow of latex, makes an end to the latex system. The tree will then make an effort to produce new latex and will continue to do so until equilibrium has again been reached.

It is a well-known fact, that the daily quantity of latex obtained by regular tapping *increases* during the first two to four weeks after opening the cut. After that time the yield of latex and its content of rubber varies round a mean figure. This mean may increase during the first few years of tapping, and this increase is very marked in some trees.

It can easily be calculated what production of latex takes place when a tree is tapped regularly for a considerable time. The size of the latex vessels is about 0·015 m.m. in diameter. Take a tree 20 mtrs. high with a circumference of 200 c.m. and with 20 latex rings. The total volume of the system would be 2000 x 200 x 20 x 0·0015 cb. centre : if each ring was a complete cylindric ring. But this is not the case. Each ring is composed of a network of latex vessels, and the total volume of the latex vessels will scarcely amount to half of the above volume or 6000 cb. c.m. The full content of the system will at any time given not be more than about 6 kg. of latex. Many trees of this size are yielding over 20 kg. of latex per year or about 1 % per day of the tree's whole latex content. The daily yield gained from good yielders may reach over 2 % of the total latex in the whole system, and it is clear that tapping must influence the physiological life of the tree considerably.

It has been shown by BOBILIOFF that the latex is only flowing from that part of the system lying vertically under the tapping cut, and from a small margin on each side. The flow of latex from the surrounding system is so slow, that we do not need to take it into consideration. When the number of latex rings and the extent of the tapping cut is known, it is possible to calculate roughly the length of the system from which the latex gained has been drawn. When good yielders are tapped, this length may often reach 1 mtr.

From the foregoing it may be assumed that the main part of the latex taken out by tapping must be replaced by production in the same section of the system from which the latex has been drawn. The work required by the cells to keep up such a production must be very considerable.

THE DRIVING POWER IN LATEX PRODUCTION.

The incision and constant flow of latex may be regarded as the motive power for the production of latex in the tree as the tree is trying to replace the liquid taken out of it. If the tapping is stopped the production of rubber will continue in the latex vessels for some time, but gradually decrease until it ceases altogether.

In the latex, water, rubber and certain salts and organic matters are taken from the tree, and therefore tapping puts a strain on the tree which is especially marked in two ways.

Firstly, the tree will have to renew the bark consumed, and secondly, the rubber producing cells are forced to work to replace the latex.

The consumption of bark was for a long time the only point considered by planters and rubber experts. As the tappable bark is the chief asset of any rubber plantation, it is clear that it must be preserved to allow of a continuous production. The effort of planters to maintain a safe tapping system with regard to consumption and renewal of bark has resulted in a decrease in the number of tapping cuts, and in the adoption of a shorter cut. One cut on a quarter, daily or on alternate days, was the rule which was more and more coming into vogue previous to the recent slump in the price of rubber.

By cutting the bark away it is at once evident that we are taking something away from the tree. Consequently "overtapping" and "hard tapping" is understood generally to mean a system of tapping, where the consumption of bark takes place at a faster rate than renewal, or where the trees are badly wounded.

Some Estates take into consideration the fact that several of the elements necessary for the development of the trees after wintering are taken away by tapping. Resting of the trees during the wintering period is common in Ceylon, India and Java, where the dry season is more pronounced than in Malaya, and the yield of latex during this time is low.

During the last few years it has been shown that Brown Bast is a destruction of the cortex, caused by overworking the latex producing cells. It is, therefore, necessary to take into consideration, when choosing a tapping system, what work that system will demand of the latex producing cells. It has in fact become necessary to undertake a new analysis of the tapping process, and its influence on the life of the rubber trees, in the light of the experience gained from the results of Brown Bast investigations. Such an analysis is best carried out by first studying the rubber tree as a bark renewer, and then as a manufacturer of latex.

THE RUBBER TREE AS A BARK RENEWER.

There are not many trees which are quicker in healing wounds and bruises of the bark than the untapped Hevea tree. It is quite remarkable to observe how quickly young rubber trees are able to renew their bark when deer have stripped them for several feet right round. When trees

are stripped as a cure for Brown Bast, the renewal of the bark is also remarkably quick. Wounds from knife cuts or similar instruments are soon overcome and the same is the case with damage done to the bark by carts, clearing gangs or cattle.

It is easily shown that tapping lessens the tree's ability to renew its bark. After the first tapping, the bark is renewed in a *couple of years.* After the next tapping over the same portion of the tree, the renewal will require four to five years and after another tapping it will take the tree six to seven years to form mature bark again. The slower bark renewal for each succeeding tapping is not solely due to decreased vitality of the tree on account of age, because if tapping is stopped for some time, the bark renewal will go on at a quicker rate. However, the renewal on a V cut over $\frac{1}{2}$ the circumference seems to be no slower than on a $\frac{1}{4}$ cut. The production of rubber seems, therefore, to require more energy from the tree than that required for renewal of its bark.

The bark is for the greater part nourished by the descending current in the sieve-tubes. If the lower section of the tree is tapped before the upper it is likely that the later tapping, by cutting off the downwards flow retards the renewal of the lower sections of bark removed by the first tapping. The upper tapping section will also take as much nourishment for itself as it possibly can, and for this reason there may not be enough left for the lower cut. Sooner or later the lower section must be influenced by the tapping cut of the section above, and forced to partake in the production of latex. The lower section may therefore gradually be underfed and exhausted, and it would seem better always to start a tapping cut as high as possible and continue to the ground instead of first tapping the lower section and afterwards one above.

It is not always easy to decide if renewed bark is mature or not. Mature bark means bark which is fit for tapping. Appearance and thickness, colour and hardness, usually influence the decision, but in many cases the deciding factor is whether tapping can take place without unduly wounding the tree.

It is not easy to undertake exact measurement of the thickness of bark, but very finely adjusted instruments for such purposes may now be obtained. It has been proved that the better growth of the bark resulting from tarring with creosote, etc., is caused mainly by a greater activity of the cork cambium. It is a Cork layer with stone-cells and not latex rings which is developed. The thickness of the bark is consequently not always a good indication of maturity, and it would seem better to stipulate that the new bark should have the same number of latex rings as the original bark before it is called mature. The Dutch have lately developed a method by which the number of latex rings in the bark can be counted with *the naked eye* or a small magnifying glass, and a cooly can prepare daily 400 pieces of bark for examination.

THE HEVEA TREE AS A RUBBER PRODUCER.

Different tapping systems influence not only the ability of the tree to renew its bark, but also its capacity to produce latex. Different tapping systems using the same amount of bark per annum may give quite different yields of rubber. The different systems must, therefore, put a different demand on the work of the rubber producing cells. Generally, it may be said that, other factors being equal, *the less the consumption of bark, the greater is the work required of the rubber producing cells.*

This fact is not very well understood. It is usual to see stated that an estate has introduced a milder or more conservative tapping system by going from a V cut on half the circumference to $\frac{1}{3}$ or $\frac{1}{4}$ cut. Only the consumption of bark, and not the work to be done by the rubber producing vessels is taken into consideration. As far as the latter is concerned, the present system of $\frac{1}{4}$ cut daily tapping is far from mild, and is perhaps the hardest system so far brought into general use. Until quite recently the aim of most planters was to procure as much rubber as possible with the least possible bark consumption. The tapping system which seemed to meet these two requirements was chosen as the best. It is since the cause of Brown Bast was discovered, that people have begun to learn that some of the tapping systems may place too great a strain on the productive energy of the rubber producing cells. It is now accepted that the work of the rubber producing cells can be overtaxed to such a degree, that the cells become exhausted and die. It would, therefore, be useful if a method could be found of ascertaining the strain which the different systems of tapping put on the latex producing cells. But first of all we have to find out, when and for how long the rubber producing cells perform their work and under what conditions they are resting.

As already mentioned, the incision and consequent flow of latex may be regarded as the force which is causing the secondary production of latex in the tree. As the different tapping systems differ from each other with regard to the number of cuts per inch, length of cut, and interval between two tappings, a comparison of the result gained in the yield of latex by each of them would seem to give some indication of the way the rubber producing cells are working, and especially of the length of time they continue to work after the incision is made.

A comparison of the yield of rubber obtained from equal areas of bark is required before answering these questions.

Let us compare the total yield from the lowest 20" of the full circumference of the bark tapped by $\frac{1}{4}$, $\frac{1}{3}$, or a V cut on $\frac{1}{2}$ of the circumference. We find that more rubber is obtained from the section when the length of the cut is reduced. The result is approximately, that is 10 lb. of rubber is obtained by tapping the whole of the section with a V cut on $\frac{1}{2}$, 15 lb. will be harvested if the section is tapped by a $\frac{1}{3}$ cut and 18 lb. with a $\frac{1}{4}$ cut.

A quite different result is obtained if the section is tapped with the same cut, but with different intervals between two succeeding tappings.

Tapped with V cut every day the yield of the whole section would be as before, viz:—10 lb. of rubber, but with a V cut on alternate day tapping, the whole section would only yield about 11 lb. of rubber and with a V cut on every third day tapping about 12 lb. of rubber.

We would, therefore, be able to get the same section of bark to produce the following amount of rubber by altering the length of the tapping cut, or the interval between two succeeding tappings.

V	cut,	daily	tapping	10 lb.	in	2	years
$\frac{1}{3}$	,,	,,	,,	15 ,,	,,	3	,,
$\frac{1}{4}$	,,	,,	,,	18 ,,	,,	4	,,

V cut, daily tapping 10 lb. in 2 years.
V ,, every second day 11 lb. in 4 years.
V ,, ,, third day 12 lb. in 6 years.

From this table it becomes evident that the more incisions a certain bark section is given, the more rubber it produces.

The latex production started by an incision probably stops before the end of twenty-four hours, because it will be seen from the above statement, that the total production of latex is only increased slightly by lengthening the interval between two tappings to more than 24 hours.

There is also very little increase in yield by tapping the section daily during one month, and then stopping for one month or tapping one month and stopping for two months. The yield would then be :

V cut, every day tapping 10 lb. in 2 years
V cut, every alternate month 11 lb. in 4 years
V cut, every third month 12 lb. in 6 years.

From these figures it may be concluded that the activity of the latex producing cells finishes a day or two after the last incision is made, and that the cells are then resting until the bark is given a new incision. The production of rubber is kept going without stopping under all every-day tapping systems, and the total work of the rubber producing cells of a certian section of bark is increased when the tapping cut is shortened.

The $\frac{1}{4}$ cut, daily tapping, and as many cuts per inch as possible was the system adopted for many years by most estates as being the most conservative and harmless. The result of our arguments above tend to show that this system must be the one placing the greatest strain on the latex producing power of the cells. The fact that Brown Bast (which is destruction by exhaustion of the rubber producing tissues) in recent years has developed and become more prevalent, shows that we, by $\frac{1}{4}$ cut daily tapping, have reached the limit of the work which we may force the latex producing tissues to do.

THE WORK PERFORMED BY THE RUBBER PRODUCING CELLS.

We have in the foregoing tried to come to an understanding of why, when and for how long the rubber producing tissues are working on the production of new latex. We shall now try to find a method for comparing the different tapping systems by their relative demands on the latex producing activity of the cells.

It has been shown by BOBILIOFF, that the latex by ordinary tapping is drawn from the bark lying vertically under the tapping cut, and about 5 c.m, on each side of this strip. If this latter effect is the same whether we use a long or short cut, which seems reasonable to expect, the rubber tapped by V cut on half the circumference of a tree of 60 c.m. circumference would be drawn from a piece of bark 30 plus 10 40 c.m. broad.

If the same tree was tapped by $\frac{1}{3}$ cut, the width of the yielding bark section would be 20 plus 10 = 30 c.m. and for $\frac{1}{4}$ cut, it would be 15 plus 10 = 25 c.m.

The vertical effect may in all three cases be taken to be the same, i.e., the bark from which the latex is drawn is in each case of equal length.

If BOBILIOFF's assumption is right, we must expect to find that the average daily yield for the three systems mentioned would be approximately proportionate to the width of the bark yielding the latex. In the above mentioned cases the proportion should be as 40 : 30 : 25 for V, $\frac{1}{3}$ and $\frac{1}{4}$ cut respectively, or if the yield obtained by tapping on a tree 60 c.m. in circumference is taken as 100, the proportion should be 100 : 75 : 62. The average proportions for trees varying from 40 to 220 c.m. circumference should be : 100 : 72 : 58.

The real proportion of yields obtained by V. $\frac{1}{3}$ and $\frac{1}{4}$ cut according to practical experience is 100 : 64 : 56 and for $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$ cut, it is 100 : 80 : 69. The average actual tapping figures are therefore :— 100 : 72 : 62.

The actual tapping results seem therefore to agree quite well with the calculated results from BOBILIOFF's experiment. The assumption that the horizontal effect of the tapping cut is the same whether we use a long or a short cut, is therefore justified for further calculations.

The fact that the total yield of a certain piece of bark is increased when the tapping cut is made shorter may be taken to be a direct consequence of the inflow of latex from the bark on both sides of the section lying vertically under the tapping cut.

If we use a tapping cut covering the whole circumference of the tree, there would be no room left for this horizontal inflow. If we are right in our assumption that the production of latex is the immediate consequence of tapping the tree, and that the production of new latex is limited to about the same quantity as that drawn off by tapping, it is evident that a cut round the whole circumference would be the system which, in proportion to length of tapping cut, would put the smallest demand on the latex producing activity of the cells. Let us assume that the demand made by a cut round the whole circumference under every day tapping is 100.

The demand which $\frac{1}{4}$ cut is putting on the rubber producing cells in the area of bark tapped, would then be calculated as follows for a tree of 40 c.m. circumference.

The cells on a width of 10 plus 10=20 c.m. are called on to produce rubber each time a bark strip of $\frac{1}{4}$ circumference is tapped. The rubber producing cells of the whole bark-section are, therefore, made to work (4 × 20) divided by 40 or twice as many times as when the section was tapped by one cut round the whole circumference. The demand put on the working capacity of the cells by the last mentioned system was assumed to be 100, and measured by that, the demand made by the $\frac{1}{4}$ cut would consequently be 200.

We can now work out a formula for comparing the total demand of tapping systems differing only in length of cut :

Take "D" as total demand of the system over the period necessary to tap the whole circumference,

" "C" as the circumference of the tree in cmtr.

" $\frac{C}{Y}$ as the fraction of circumference tapped.

and assume our conclusion from BOBILIOFF's theory that the latex flows from 5 c. m. each side of the cut. Then if we take the demand made by one cut round the whole of the circumference as 100 :

$$D = \frac{\left(\frac{C}{Y} + 10\right) Y \times 100}{C} = 100 + 1{,}000 \frac{Y}{C}$$

From this formula we may conclude that the demand on the work of the rubber producing cells is increased when the length of the cut is shortened, because the factor Y/C will increase. For cuts on whole, half, $\frac{1}{3}$ and $\frac{1}{4}$ of the circumference Y/C would have the values 1/C, 2/C, 3/C and 4/C respectively.

We may further conclude that the same tapping system makes a smaller demand on the tree's rubber producing activity as the tree becomes older, and the circumference increases.

The proportionate demand of the different tapping systems for trees of different sizes on every day tapping would be :

Circumference Cmtr.	40	60	80	100	150	200	250	300
Demand for ½ cut.	150	130	125	120	113	110	108	106
,, ,, ⅓ ,,	175	150	137	130	120	115	112	110
,, ,, ¼ ,,	200	170	150	140	127	120	116	113

It will be seen from this table that a quarter cut puts the same demand on a tree's rubber producing activity as a ½ cut does when the tree has only half the circumference. The quarter cut system is about 30 pct. more severe than the ½ cut when the tree's circumference is 40 cmt. (16 inches), but only about 6 pct. more severe, when the tree is 300 cmtr. (120 inches).

It is fortunate that the V cut on half the circumference was the system generally adopted when estates started tapping, and that the ¼ cut was only introduced when the trees had reached a more mature development.

From the figures in this table we may also reasonably conclude that if a tree does not develop Brown Bast when tapped with a V cut on ½ the circumference, it is not very likely that it should develop the disease after it has doubled in circumference, and the system is then altered to ¼ cut.

The length of the cut is not the only factor ruling the rubber producing activity of the cells. The number of times this activity is used before the cell is cut away must also be considered.

We must suppose that each tapping cut is causing a certain effect on the cells, an effect which is most severe on the cells nearest to the cut, and decreasing at a constant rate for more distant cells until it is not felt at all. A cell which is lying more than one meter from the tapping cut will very seldom be affected by it. Comparatively speaking this cell will be at rest as regards the production of latex. But as the tapping cut is moved downwards this cell will come under the influence of the cut, and start producing latex. The demand on a cell is constantly increasing as the cut is coming nearer and nearer to it and is at its greatest just before the cell is finally cut away by the tapping cut.

The total demand on a cell may in this respect be expressed by the formula :

$$\frac{1}{2} N^2 L^2 p.$$

('N' being the number of cuts per inch—'L' the distance of the cell from the tapping cut, and 'p' the small increase in demand on the cell's producing power for each new tapping cut).

The total demand on a cell would, therefore, be proportionate to the square of the number of cuts per inch, and to the square of the distance of the cell from the tapping cut at the point where it begins to affect the cell.

Twenty cuts per inch make the cells do four times the work they have to do for 10 cuts per inch. The total demand on a cell lying three times as far from the opening as another cell, but inside the influence of the cut is

nine times greater than that on the nearer cell. From this one will understand why Brown Bast is so often formed near the collar of the roots. The total demand on these cells is considerably greater than on the cells higher up the trunk.

The third factor influencing the demand on the rubber producing activity of the cells is the interval between two tappings.

If the process of restoring the latex in the cells were complete within 24 hours after tapping then the demand on the cells by tapping every second day would only be 50 per cent. and by tapping every third day $33\frac{1}{3}$ per cent. of the demand by tapping every day. However, from the table on page 558, it will be seen that if a tree is tapped by V cut every second day, the yield during a year will be about 55 per cent. of the yield by tapping every day, and if the tree is tapped every third day only, the yield will be about 40 per cent. The rubber producing activity of the cell must therefore still be in action twenty-four hours after the last tapping cut was made. It is also a well known fact that the rubber contents of the latex will increase when tapping is stopped for some time.

It seems reasonable to assume that the demand on the rubber producing activity of the cells is about 30 per cent. less by tapping every other day and 55 per cent less by tapping every third day, compared with tapping every day.

A few examples may help to show the importance of these results in practice.

If the tapping system on a tree 80 cmtr. in circumference is altered from a V cut every second day, and 15 cuts per inch to a $\frac{1}{4}$ cut every day and 20 cuts per inch, the demand on the rubber producing activity of the cells will be increased from 125 less 30 per cent. *i.e.* 88 to $150 \times (20/15)^2$, *i.e.* 267, or about three times as much as in the first case.

If the tapping system used on a 60 cmtr. tree is altered from a V cut every other day, and 15 cuts per inch, to a $\frac{1}{4}$ cut every day, and 30 cuts per inch, the demand on the rubber producing activity of the cells would be increased from 130 less 30 per cent. *i.e.* 91 to 170×4 *i.e.* 680, or to more than seven times the demand made by the original system.

We will now recapitulate the formulæ for comparing the demands of the different tapping systems on a given tree :

$$\text{Demand due to length of Tapping cut} = 100 + \frac{1{,}000}{\text{length of cut in cmtr.}}$$

Demand due to number of tapping cuts per inch = Square of number of cuts.

Demand due to sphere of influence of cut = square of the distance from the cut of the most distant cell affected. (This distance may be roughly calculated as $100 \times$ the average daily yield of latex in cb. cmtr. divided by the length of cut in cmtr. plus 10 cmtr.)

Demand due to Tapping Frequency = Alternate day tapping = 30 per cent. less than every day tapping, every third day tapping = 55 per cent. less.

The recent Brown Bast investigations support to a great extent these formulæ.

These investigations have not yet succeeded in showing any relationship between the length of cut and the appearance of Brown Bast but the disease has spread considerably since the ¼ cut system was generally adopted.

As regards the number of cuts per inch, it has been found that about four times as many trees developed Brown Bast by tapping 40 cuts per inch as by tapping 30 cuts per inch.

As regards the distance at which the effect of the tapping cut is felt vertically, the results of investigations of Brown Bast cases in 'good' and 'bad' yielders may be mentioned. It is generally found that if the trees are divided into classes according to yield, the number of Brown Bast cases is much higher in the good yielding than in the inferior yielding classes.

The effect of the tapping cut reaches much further down on a "good" than on a "bad" yielder, and the demand on the rubber producing activity of the lower cells must be very great for heavy yielders.

As regards "tapping frequency," it has been found that approximately double the number of trees were attacked when the trees were tapped every day with ¼ cut, as when tapped by the same cut every second day.

As a general rule it may be said that the renewal of bark is an easier task for the trees than that of keeping up its latex production. As long as the renewal of bark keeps up to requirements, this question is practically of no importance compared with the strain which tapping puts on the tree.

We may in conclusion repeat some of the points to be remembered when choosing a tapping system:

1. Every day tapping forces the cells to produce latex practically without a rest. In every day tapping the number of cuts per inch ought not to be carried to extremes. A consumption of 18-22 inches of bark a year should be taken as normal. In a few years time it is probable that most estates will have abolished every day tapping, as the strain on the tree is so heavy that Brown Bast is developed very frequently.

2. Alternate day tapping on half the circumference is a milder system than every day tapping on ¼.

3. A short cut puts a heavier strain on the cells than a longer cut.

4. Cessation of tapping means rest for the latex producing cells.

5. If consumption of bark is taking place at a faster rate than renewal, it would be better to change to every other day tapping, than to introduce a new cut.

6. If a tree develops Brown Bast or is running dry, it is evident that it in future should be tapped by a milder system.

7. A "V" cut continued for 40 inches vertically puts a smaller demand on the cells than ¼ cut 20 inches vertically. The amount of rubber gained over a period of 4 years is about the same in both cases.

8. If tapping experiments are compared, it is important to keep the same number of cuts per inch for each system, and the number of cuts per inch ought always to be recorded.

9. The tapping cut should always be started at the highest point of the tapping surface and brought down to the ground, before a new surface is started.

10. In order to prevent the spoiling of a tapping surface neither the length of the tapping cut nor its direction should be changed, nor should a system of new cuts be started until a new surface is opened.

11. Alteration of the tapping cut should only be introduced gradually on an estate. The alteration requires great care on the part of the management. This alteration is more difficult to carry through without doing damage, than to alter a system from every day tapping to every other day or to exclude the bad yielders from the tapping round. The latter precaution can never cause harm, but alteration of the tapping cut may result in harm which may take several years to overcome.—ARCHIEF VOOR DE RUBBER-CULTUUR, 7e Jaargang, No. 12.

PHYTOPHTHORA LEAF-FALL OF RUBBER.

H. W. R. BERTRAND,

Govinna Estate, Ceylon.

In the absence of cultivation the Phytophthora infections, if not more severe, at least become a more serious menace. When the normal wintering period ends the tree has stored up a reserve of food whose principal use in the Spring is the formation of new leaves and shoots. By June-July, the tree having completed its new canopy of leaves, these reserves of food are at their lowest, the manufacturing ability of the new leaves has not as yet been able to replace the depletion caused by their growth. It is at this period that the abnormal leaf-fall caused by Phytophthora begins and in many cases trees are depleted of more than half their leaves, often they are left almost leafless. This secondary leaf-fall involves two physiological considerations.

(a) The tints of autumn foliage, among the loveliest and most interesting of natural phenomena, are the flags of economy. The natural death of the leaf is preceded by cessation of the output of chlorophyll, all available foodstuffs in the leaf are transferred, for safe storage, to the stem, and the tree, before the leaf-falls, begins to build a protective corky tissue over the wound of the dying leaf-stalk.

When, however, a leaf stalk is attacked by Phytophthora the tree seldom has time to take these protective measures, the ground will often be seen strewn with green leaves cut off full of useful plant-food and in the prime of their activity.

(b) Great as is this loss to the tree the loss in earning power of its "factory" is greater. The process of manufacture which goes on in a tree is known as photosynthesis. One of the first, if not the first, of the products of photosynthesis is sugar. From this substance all carbon compounds, in the tree, are subsequently made. The rate of photosynthesis for Hevea has apparently not been determined (though it might well be, seeing that the amount of hydro-carbon in the form of rubber which we remove is determined by it) but it will probably not differ much from that of most plants for which the rate has been found to be about 1 gramme of

sugar per square metre of leaf area per hour. In 1923, between June and August, leaf-fall was so bad that, on many estates, had the leaves been spread out, they would have covered the whole acreage. Taking an estate of 600 acres this equals 2,640,000 sq. metres. For a 4 hour day of effective sunshine this works out at a daily loss of some 10 tons of elaborated plant food. Converted into terms of rubber, without allowing for the unknown factors of new growth and maintenance of the plant, this represents a week's tapping. During the dull wet days of the S. W. monsoon it is unlikely that the rate of photosynthesis approaches the figures given but it seems apparent that the drain on the tree due to tapping bears but a small ratio to the loss caused by leaf-fall. This is borne out by the growing opinion among many practical men that the resting of rubber to be of any use should be prolonged. It is, moreover, little wonder that, without high cultivation to enable the tree rapidly to make good its loss before the next wintering period begins, the trees become stag-headed, yellow and unhealthy and that such facultative parasites as Ustulina and Diplodia are slowly but very surely taking an increasing toll of the capital value of estates.

Brown Bast is increasing and must be regarded as one of the biggest factors, if not the biggest, in the falling off in yields, but Brown Bast should be regarded as an effect and not the cause. It is not improbable that the cessation of food supply caused by leaf-fall during tapping may be a factor in the increase of this "disease." A sidelight is thrown on this by the published report of a recent investigation in the Straits where an unexpected increase in the incidence of Brown Bast was noticed during a prolonged period of wet weather. It is not mentioned whether there was leaf-fall, but in any case in a saturated atmosphere there can be practically no absorption of minerals without which the elaboration of plant food ceases. This may be proved by direct injections into the stem, the plant will take up more in a few hours of sunshine than it will during many days of rain.

There is another aspect to consider. The heavy leaf-fall this year, combined with an unusually wet season, induced a great many surface rootlets. There was practically no break in the rains from the middle of May until October 3rd. From then until the 11th, there followed a period of bone-dry weather. On this estate yields fell off daily from *7·04* lb. per tapper to *5·91* lb. It was found that the mass of surface rootlets had been completely killed off by the short drought and one could rake them up literally by handsfull.

The various forms of Phytophthora are, in the writer's opinion, responsible for more damage to estates than all the other diseases put together.

"Black Thread" is more harmful than the worst tapper on any decently run estate; in continuous wet weather it is extremely hard to keep in check and with the most careful supervision a number of trees have many inches of tapping surface put out of action for years. Its greatest danger is that the extent of the wounds is not immediately apparent.

Stem Canker damages tapping bark, and is responsible for the death of many trees, and in a great number of cases branches are "rung" by it and either killed or rendered almost useless. Ustulina and Diplodia are wound parasites which in the majority of cases effect their entry through old Canker wounds or through the snags of branches killed by Canker or Leaf-fall.

If soil erosion is "the most serious menace to the Tropical planter" there can be little doubt that on a well drained estate Phytophthora in its various forms is a graver menace to the Rubber planter. It may not be possible to check it at its inception but one feels that if no serious attempt has been made it is because its importance has not been realised. The question resolves itself into (a) fungicidal, (b) manurial treatment.

The first would involve a search for a harmless, cheap and adherent fungicide and a rapid and effective means of application. Space forbids going into the question more fully but, bearing in mind the ever present possibility of an epiphytetic invasion, is it well to neglect an investigation which in the present seems advisable and in the future might become a grave and urgent necessity? If mycologists are agreed that the spraying of high trees is impracticable, it is possibly because no vast area of such economic importance as Rubber has called for it.

(b) A closer study of the effects of manurial constituents and of the times of application has been suggested and deserves attention though past experience with other crops is not encouraging.

TAPPING OF RUBBER.

The BULLETIN OF THE RUBBER GROWERS' ASSOCIATION, October 1922, p. 510, contains an article by MR. SIDNEY MORGAN on the systems of alternate periodic daily tapping and resting. These systems of tapping are specially important since they enable estates (1) to arrange a beneficial scheme for a restricted output, and (2) to reduce the cost of tapping per lb.

From a study of the results obtained on estates where the new systems have been longest in practice, the writer has arrived at the following conclusions:

(1) On the whole it is found that the output of the second month is the best.

(2) From an analysis of weekly output it is not possible from the data available to state which week of the second month gives the maximum out owing to varying weather conditions. The evidence available indicates that the last week of that month is as good as any other.

(3) In some cases the third month give the best result on equal periods of tapping and resting; or a result approximating to that of the second month. However, it is generally found that the output of the latter portion of the third month falls below that of the opening days.

(4) In periods of half tree tapping extending over four months there is generally a decided decrease in the gross output of the fourth month.

(5) More complete records of experiments carried out on a large scale are necessary to determine definitely the optimum period of tapping and resting, but the writer is of the opinion that two months is the optimum period.—BULL. OF IMP. INST., VOL. XXI., No. 2.

COFFEE.

GRAFTING IN COFFEE CULTURE.

DR. P. J. S. CRAMER.

(Translated from the Nederlandsch Indisch Rubber en thee Tijdschrift No. 1. of 1923, by H. L. Ludowyk, Librarian, Department of Agriculture, Ceylon.)

(Continued from the February Number.)

ADVANTAGES DERIVED.

Uniformity.

In this part of my article I intend to dwell upon the numerous benefits that are to be derived from grafting. They were touched upon *en passant* in the previous pages. The greatest advantage which shows itself so distinctively, and so decidedly outstrips all the others as to give them the appearance of being but of minor importance is the very perfect state of uniformity which can be reached by grafting with scions from the same parent tree. If a plantation grafted with scions from one parent tree be compared with one that has trees raised from ungrafted seedlings, even though the seeds were from one and the same tree, the difference between the two plantations, the marked uniformity of the grafted plantation and its superiority over the other will be obvious. From the practical point of view, uniformity is so important an asset in a plantation that, in the temperate countries where the methods adopted are generally of a higher standard than those resorted to in the tropics, both gardeners and agriculturists have now finally come to be impelled by a desire for its attainment as the principal motive for taking to grafting on a large scale.

As part and parcel of this uniformity is another attendant advantage: one is able to form a very close estimate, almost to a point of certainty, of the future behaviour of the grafted plant. In the case of a plant raised from seeds which generally are subject to variability, one can never form an idea as to its behaviour. The chances of variability can surely be reduced to some extent by selecting all seed for planting from one seed-bearer; but, speaking from practical experience, such genetically pure planting material as that obtained by grafting can never be raised from seed. When a person once knows what results a certain species grafted upon another gives under certain given conditions, he is able to arrive at any desired result by judicious combinations. In this manner the good characteristics of a relatively small number of plants can be distributed true and undiminished in vigour without loss to the plants used, over a large area. At Bangelan for instance in the small plots with 16 plants in each we have quite enough planting material for ourselves, and even smaller plots would have sufficed up to the present time.

Uniformity is the most important characteristic that we are most keen on seeing our plantations acquire. When we recount our experiences at Bangelan on this head we are led to conclude that uniformity alone

was not the characteristic perseveringly worked for and eagerly looked forward to. Variations and peculiarities which never occurred were indeed expected by those who were quite unaware of the fact that grafting would result in the existence of plots which were peculiarly remarkable by their strict uniformity.

CONDITION OF THE PLANTATION.

As first among the attributes of the great state of uniformity attained by grafting I shall place the condition or general health of the plantation. If one has planted a plot with trees grafted from the same parent tree, then all the trees on the plot are of the same standard and condition. In direct contrast to a plantation raised from seed, where good and bad trees, sparsely and densely foliated trees, are to be found side by side, one planted with trees grafted with scions of the same parent tree has either all good trees, with strong healthy branches that are densely foliated, or all weak ones which after the harvest, for example, are attacked by the leaf disease and drop their leaves as a sequel to it. The trees of each plantation in the case of the former resemble each other very closely : either they are all well balanced and of good form, or they are all uneven, disproportionate as to their members, and resemble each other in all these unfavourable aspects. In this respect the grafted plots at Bangelan, especially those small plots known as the "Show Plots" serve as very instructive specimens. As the plots here are small the trees can easily be compared one with another and the truth of the statement regarding their uniformity will be undoubtedly confirmed at a glance ; every tree on a given plot the observer will notice exhibits the same conditions of habit and health.

In 1919 one of our veteran coffee planters paid a visit to Bangelan very shortly before he bade farewell to Java for good. I took him to these model plots and reminded him of the remark he made when I commented on the good or bad habit of some of the individuals of what he pointed out to me as being regular and uniform plots of Robusta or Canephora. "Oh," he said at that time, "the root of that tree has reached a hard pan." I brought him before a plot of pretty good Uganda trees which were hard by a number of remarkably good specimens and asked him, "I am sure you will not be willing to affirm that all these sixteen trees have their roots impeded by a hard pan and that the neighbouring trees have no such impediment. Then he gave in and admitting his error said, "You are right, doctor. We should then no more resort to propagation by seed; we should adopt the method of grafting." "Quite right," said I to him, "but we have not progressed so far, yet Bangelan will do its best towards proceeding in an orderly fashion to establish the best practice."

QUALITY OF CROP.

I come now to the second characteristic that marks the uniformity of grafted trees—uniformity as regards quantity produced per tree. Speaking in general, there is more uniformity in this respect among grafted plants than among those propagated by seed. Examining the small grafted plots on Bangelan Station one notices at sight that every plant on the same plot has about the same quantity of berries on it. If one tree of the plot is a bad producer one can rest assured that the others too bear badly: if one

grafted plant on a plot is noticed to be heavily laden with berries, then every graft on that plot is sure to be as productive as that one; if one tree of a plot suffers from the effects of bearing too abundant a crop, then all the trees of that plot in like manner exhibit the same symptoms. In a plantation of Robusta raised from seedlings one always finds a certain percentage of very bad producers; the percentage of such poor producers is noticed to be large on a similar plantation of Liberian coffee. There are often many of such poor producers on some plantations as do not produce enough to cover the cost of their upkeep, so as even just to justify their existence. Such trees never find their way into a plantation of grafted trees, except perhaps in a certain instance of which I shall treat later.

I will not make bold to say that all the trees of a plot grafted with the same parent plant give precisely the same amount of manufactured coffee. So far we have conducted but one small experiment in this regard ; the experiment was conducted with the products of thirteen (quondam) irregular Canephora trees which were grafted on the field with Robusta. The product was gathered and records kept every consecutive year. The product is here given in kg. (manufactured coffee).

		1918.	1919.	1920.	1921.	1922.	1923.	Average for 6 years.	Average for 4 years.
125	1.	2·254	0·950	0·167	2·334	3·468	2·088	1·875	2·536
,,	2.	3·212	1·065	2·153	2·490	3·607	1·539	2·344	2·712
,,	3.	1·352	0·675	0·140	1·969	2·110	1·685	1·321	1·779
,,	4.	2·131	0·631	0·851	3·350	3·510	1·187	1·941	2·644
,,	5.	1·334	0·741	1·222	2·864	1·601	1·208	1·495	1 776
,,	6.	0·931	0·430	0·731	2·951	1·597	0·694	1·222	1·543
,,	7.	1·471	0·196	0·488	2·322	0·836	0·413	0 954	1·260
,,	8.	3·874	0·770	1·482	1·156	1·032	0·989	1·700	1·987
,,	9.	1·796	0·528	0·371	1·853	2·404	0·649	1·266	1·675
,,	10.	1·573	0·346	1·958	3·036	4·718	1·787	2·234	2·776
,,	11.	0·944	0·322	0·397	1·560	1·687	1·667	1·096	1·464
,,	12.	2·472	0·287	0·887	1·869	3·208	0·623	1·557	2·043
,,	13.	2·587	0·646	0·702	2·008	2·732	1·221	1·649	2·137
Average per tree per year		2·00	0·58	0·89	2·29	2·57	1·21		

In the last column the average is taken without reckoning the two years in which there was a failure of the crop.

It will be noticed that the total for six years keeps within a fair distance from the average and does not vary very much. The minimum is greater than half the average, and the average bears about the same proportion to half the maximum as half the average bears to the minimum. It should also be borne in mind that the course of manuring was not uniform but underwent a great deal of change. In addition there occurred two failures of crops in this series of years, due to the ravages of the boring beetle in 1920 and the kloet pest in 1919. The trees were also used as parent trees and many scions were taken from them for grafting. In spite of all these drawbacks the products of the individual trees are less inconsistent than those obtained from trees propagated by seed.

We have lately started some similar experiments by keeping records of produce of some annual crop plants that have been propagated and improved by means of vegetative propagation. The conducting of these experiments is really not as simple as people would generally expect them to be. The Cinchona experiment station is now occupied in the conducting of some important experiments on these lines. The nature of the crop however renders it very difficult to compare the results of these experiments with those of the experiments on coffee. This year we intend starting upon some such experiment in Bangelan in order to determine some facts regarding the product of individual trees in the grafted plots. Here too some relative fluctuation in the product might be traced, but it should be borne in mind that an important factor causing variations in the individual products of trees raised from seedlings is eliminated by grafting and this factor is the hereditary tendency to variation. It is true that this factor is not only eliminated but that the vigorous growth of the stock, the maturing of the wood, the position of the scion on the parent tree from which it was taken, the simultaneous growth and fusion of the stock and scion are other factors that enter and influence the product. I will not go further into this matter but merely say that if you compare a grafted plantation with one raised from seedlings as regards the evenness of the quantity of the product, you will agree with me and see the truth of my statement that the trees of the former are more uniform in the quantity of the product of each tree.

In the case of ungrafted trees we do find generally some extraordinarily good producers. The figures showing products of the parent trees in Bangelan testify to the fact that these superior specimens give every year a product above the average while, to cancel the benefit derived from them, certain other trees in the same plantation give hardly any crop for years on end. As I have already stated, as far as my experience goes, every coffee plot propagated from seed and ungrafted contains a certain percentage of trees whose crop is so small and so persist every year that they are nothing but a drain on the resources of the estate as they do not with their crop pay any part of the expenses of their upkeep. Such an undesirable state of things never takes place on a plantation laid out with carefully grafted trees. It happens sometimes that we might make a mistake and graft a plot with a parent tree which we a little later on discover to be unsatisfactory. As the benefit of the whole plot is at stake we should not long be in doubt and delay but cut down all the trees to a stump and using a better parent-tree graft the off-shoots. On the Experiment Station at Bangelan however owing to the care and precaution exercised, which we shall deal with later, such errors and the resulting disappoinments are well guarded against.

CHRONOLOGICAL CHARACTERISTICS.

In tracing the different characteristics that go to make up the much desired uniformity achieved by grafting we find that they also extend in so striking a manner as to be even phenomenal as regards time : the strictest uniformity is noticed to occur in the time of ripening of the first and the last berries. I wish now to expatiate a little more largely on this point as I consider it a matter of specially great importance from the practical points of view. As far as my knowledge goes no attention has ever been given to the matter of effecting simultaneous flowering and ripening on all the

coffee trees of a plantation. In the fruit cultures, however, in the temperate climes and in the grafting of other tropical products this problem has been studied to a fair extent. It will be sufficient if I merely remind my readers that in Europe those occupied in fruit culture differentiated between 'early' and 'late' varieties of such fruits as apples, pears and peaches even as we mark out plants grafted from one parent tree. One variety ripens and comes on the market already in July while the other comes on ready for use only in the autumn months and some mature so very late that they have to be plucked and put by for some time to let them ripen. In sugar cane cultivation too similar examples are to be met with. Among the canes used for sowing too the early and the late ripening kinds are differentiated. The case of hevea grafts is a typical example and a very remarkable phenomenon as, in all plants grafted from one and the same parent tree, defoliation takes place at one and the same time, while in the case of other trees great differences are noticed in the times at which they begin shedding their leaves as well as in the duration of this process and the renewing of their foliage.

What occurs in the case of coffee? These characteristics which are noticed are from the agricultural and economic standpoint of exceptionally great importance to the industry. We have for many years collected data and recorded observations on this head at Bangelan. What can be inferred from the facts before us is that plants propagated from seed, at least to some extent, inherit the tendency of producing early or late according to the behaviour in this regard of the seed-bearer from which the seed for planting them was collected.

If the time of ripening of the berries of a plantation of grafted coffee be compared with that of one having ungrafted trees we are struck at once by the difference. The time of ripening of the berries on the trees of the latter is never the same and the differences in time are often great: some trees, before the chief harvest starts, already bear a quantity of ripe berries and at the end of the harvest, here and there on the plantation, are always found trees on which unmatured berries are plentiful. There are always before the beginning of the harvest trees with ripe berries, and at the end of the harvest scattered trees with unripe berries remain. In contrast to this, in a plantation with trees grafted from one and the same parent tree such irregularities as were noticed to occur in the other plantations are reduced to the minimum. Here the harvest time for every grafted tree is nearly identical. Red berries on one tree is a sure prognostication of the same state of maturity being attained by the berries of all the other trees: at the end of the ripening time of one tree, the ripening of the berries of every tree has been effected. If the figures for the different years be compared it will be noticed that this remarkably singular trait is not erratic but regularly and repeatedly recurs. Trees that ripened their berries early in one year will continue in a later year to produce early, and likewise for those that ripen later.

GRAFT PLOTS.

Distribution of the crop of graft plots containing some robusta plants, planted in December 1917.

Weights of coffee berries per plot 70 x 70 ft. given in Kilogrammes.

1921.

Plot Nos.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Total
59-01-01	—	—	8·0	41·0	17·8	10·6	4·7	0·6	—	82·9
124-01	—	—	—	3·9	60·6	7·9	0·7	0·7	—	73·1
105-03	—	—	—	9·8	45·0	55·7	43·9	0·5	—	154·9
78-11	—	—	0·3	33·1	—	129·8	8·5	1·2	—	172·8
59-01	—	—	0·8	30·0	—	51·1	4·5	0·9	—	86·9
Sg-1	—	—	—	0·6	1·8	61·2	53·0	30·9	6·7	148·3
105	—	—	—	0·1	4·0	33·3	75·9	9·7	—	173·0
105-01	—	—	—	—	—	35·4	11·6	6·2	—	53·3
104-02-03	—	—	—	0·1	2·8	45·3	138·5	42·4	—	229·4
105-11	—	—	—	—	—	15·9	9·8	7·9	—	33·6
Total of Crops of Robusta on Bangelan	2	27·5	392·6	25·464	31·357	72·144	34·417	20·370	506	188·468

1922.

Plot Nos.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Total
59-01-01	17·2	39·8	29·5	24·5	83·7	31·0	1·3	—	1·8	228·8
124-01	—	0·7	11·4	143·9	92·2	4·4	13·4	—	4·8	312·8
105-03	0·7	0·8	17·2	43·6	69·3	113·2	18·3	—	0·4	263·5
78-11	0·1	0·9	12·6	53·8	25·5	36·6	12·5	—	0·8	376·3
59-01	0·5	8·4	8·7	32·0	90·0	36·5	4·8	26·8	—	208·7
Sg-1	9·7	9·7	17·3	18·2	17·0	59·5	22·0	—	12·0	165·4
105	—	—	1·3	34·6	51·4	216·5	14·0	—	1·4	319·2
105-01	—	0·7	5·2	4·5	43·9	62·4	18·5	—	5·3	140·5
104 02-03	—	0·4	8·3	8·7	32·0	50·3	2·5	—	0·8	156·5
105-11	0·2	0·5	10·2	4·8	44·8	36·6	10·2	—	1·6	108·4
Total of Crops	373	2·900	15·786	40·076	73·131	91·465	57·179	9·939	3·920	294·774

1923.

Plot Nos.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Total
59-01-01	—	—	—	20·1	13·6	28·0	3·0	—	—	64·7
124-01	—	—	—	10·8	7·1	51·2	52·0	—	—	121·1
105-03	—	—	—	1·3	29·0	106·0	57·0	—	—	193·3
78-31	—	—	—	1·3	35·1	37·2	88·0	17·5	—	179·0
59-01	—	—	—	5·3	34·1	23·0	27·0	3·0	—	92·4
Sg-1	—	—	—	2·6	9·0	11·4	8·0	34·	—	65·0
105	—	—	—	—	0·5	7·5	25·0	8·	—	39·0
105-01	—	—	—	0·2	2·1	10·5	46·5	70·5	—	129·8
104 02-03 Cut.	—	—	—	—	—	—	—	—	—	—
105-11	—	—	—	—	—	5·1	35·	45·	—	85·1
Total of Crops			923	9·627	45·584	103·552	94·926	23·884	—	287·397

Table No. 1 shows the produce of the plots of grafted Robusta coffee, each plot of which contains 49 trees. Plot No. 59-01-01 is every year by far the earliest to ripen its berries; No. 105-11 is the sort that every year produces last. Take for example the figures for the year 1921. In that year the biggest crop of Robusta coffee for the whole plantation at Bangelan was gathered in the month of July. Before that month and after it about as much as the amount then got was harvested, and so we might

well put down July as being the middle or height of the harvest. Robusta plot 59-01-01 gave the most plentiful crop in May; by July it produced but little. No. 105-11 on the other hand gave its first crop of ripe berries only in July, and more than half the total amount of the crop for the year was harvested in the two succeeding months. It is quite obvious from these remarks and the tables that variations do occur but these same variations recur every year.

From these and other figures collected at Bangelan it is fairly well established that chronological characteristics as regards flowering and ripening are to a certain extent hereditary; that a seedling from a seed bearer that has the tendency to ripen its berries early inherits from it this bias and generally ripens its berries earlier than a tree raised from seed of a late producer. But this is not always so; No. 105-03, No. 105-01 and 105 are all three seedlings of the self-same parent tree and although they lie on the same plot the first falls into the category of early producers, the second which has indeed taken after its parent, No. 105, belongs to those which are neither early nor late producers but are normal, and the third is the tree that ripens its crop latest. This is an example of how trees that are not grafted with the same parent tree behave as regards the duration of ripening period; the time of harvest stretches over a longer period than that of the harvest of a plot of plants grafted with the same parent tree. From this it is clear how by the choice of grafts the duration of the harvest can be kept within desired limits and rendered very much shorter by the use of special scions

I do not propose to dwell fully here on the great importance for practical purposes that the simultaneous ripening of the berries on all trees has. Plucking can be started earlier and the plucking can be done faster and cheaper when all the trees bear ripe berries at the same time rather than when the pluckers have to look out for the ripe berries on a few scattered trees that bear them. At the end of the harvest too, during the minor harvests, much time and money is saved by the fact that all the trees cease to have ripe fruit nearly simultaneously at a definite time.

This last point is of great importance in view of the fact that quick harvesting is conducive to effectual avoidance and control of the berry boring beetle pest. At the end of the harvest as the berries begin to get rather soft and pulpy the percentage of berries attacked by the coffee berry boring beetle seems to be on the increase. In proportion to the lack of uniformity in the time of ripening of the individual trees, the chances the pest derives for spreading and giving rise to further generations steadily increase, making its control all the more difficult. The difference is clearly seen when one compares this with the percentage of beetle infected berries on an irregular (as regards time of ripening) plantation with the percentage of such berries on a plantation on which all the trees ripen their berries simultaneously.

During my visit in September which happens to be the closing time of the harvest, I obtained from HEER PARKINSON figures showing the percentage of plot 86 of Excelsa coffee and plot No. 253 of complex Excelsa individuals. The figures are given below—Plot No. 86 produced 14,780 berries of which 5,346 or 36·7 per cent, were infested; plot No, 253 produced 17,384 berries of which 2,561 or 14·7 per cent. were infested.

We see further from the records of the products of the graft plants that there are trees with long and short periods of harvest. There are sorts that have their producing periods in normal years reduced to the compass of three months only. With a view to overcoming the attacks of the beetle pest this sort is found not only preferable to the others, but they are ideal plants that can effectually evade the pest and render entire safety against it to the whole plantation if all the trees on the estate were so grafted with

one parent plant and reached this much-to-be-desired state of uniformity—ripening all berries in three months. As a resulting benefit not only will all the berries be gathered in a short harvesting period which will give no opportunity to the beetles to do their work of depredation but the plucking can all be done quickly and the work be rounded off and the danger of the breeding of new generations of the pest can be minimised. Simultaneous ripening of the berries on all the trees in a short period facilitates control measures, saves time and tends towards establishing perfect working methods on the estate.

Is it then advisable that all the estates of our coffee cultivations be planted with grafts of one of this sort of parent trees only? I will not venture to give my answer to this in the affirmative; and if any one intends to adopt this idea and pursue the method, I do now warn them against it and strictly deprecate such a step. I shall come back again to discuss this matter. What I now want to point out is that ungrafted seedlings should first be replaced by graft plants and then by judicious vegetative selection by degrees the planter should bring limitations to bear on the duration of the cropping seasons and control the distribution of the crop through the year. In a sense, what a man attains individually, without restricting himself by stereotyped plans but with due regard to the local and other conditions obtaining on his land, is best. One has to bear in mind that a plantation of ungrafted trees is composed of the three distant types of early, late and normal producers. If the crop is to be scattered through the whole year one has carefully to select and group these three sorts separately in distinct blocks on his estate instead of having a haphazard distribution of all three sorts together on the land.

I have just a few more words to say regarding the chronological characteristics in connection with the control of the berry beetle. The control of the coffee beetle by the aid of the Lady-bird seems to be successful. As it is deemed necessary that a certain number of live beetles should always be present on the estate there should also be a certain quantity of ripe berries on the trees through the year. Now, without irregularity in the crop periods, but with the prevalence of strict uniformity, this side issue will be a natural accompaniment if there is a series of divisions or plots of the different sorts of plants and the trees on the division of land occupied by each ripened its berries uniformly, Then, as there are early, late and normal producers on separate plots there will be a succession of crops through the year.

UNIFORMITY OF THE BERRY AND THE BEAN.

The fourth characteristic of the uniformity that vegetative selection brings about is noticed in the appearance of the berries as well as the market product. This might be a characteristic present in Robusta coffee but it does not show itself in such a highly marked degree. If one carefully examines and sorts one's material it will be noticed that Robusta coffee can be separated into remarkably large berry and small berry types. For example No. 59 of Bangelan and its progeny of ungrafted trees bear small berries while No. 105 and the trees sown from it bear large beans. The want of uniformity in this regard is more obvious in the case of Excelsa coffee, some of whose berries are so large that they offer much difficulty in pulping in spite of the fact that the machine used has been constructed on purpose for large beans, while the small beans slip out without being pulped at all; and if the pulper is adjusted for small beans then the large beans will all be found to be broken and cut up in bits.

In the case of grafted trees it is different. If we examine the berries of one tree and compare them with those of another tree of the same plot we see that all the berries are of about uniform size, similar in shape and the same in appearance.

It naturally follows from this that the uniformity extends not only as far as the berries are concerned : the market product of a grafted plot possesses these traits of uniformity. The product is more uniform in size and shape than the beans obtained from plants raised from ungrafted seedlings.

FITNESS OF GRAFT PLANTS FOR GRAFTING.

Finally, among the characteristics of uniformity that grafted plants possess when compared with ungrafted ones is yet another—the suitability of these trees for the purposes of grafting others. In the case of ungrafted plots in trees which are selected even from the same parent, great variations are noticed to occur. This occurs more particularly with such a variety as Liberian coffee which is difficult to graft. Some select parent trees of the ungrafted plots on Bangelan are used for grafting experiments ; but from most of them it requires a great deal of trouble to effect two successful grafts ; there are two of them on the other hand that lend themselves most admirably for the purpose of grafting and it is from these trees that scions for the larger part of the plots on the Station have been taken. And this good attribute of the tree for easily lending itself for grafting purposes is not withheld by it alone but is passed on to all the plants that have been propagated by scions from it. It makes no difference at all whether a scion is taken from the parent tree or from its progeny by vegetative selection for the splicing will take place as easily in either case and the same hereditary qualities will be handed down.

If, on the other hand, a tree be a bad subject for grafting experiments then with the successful grafts that can be effected with scions from it or its progeny it will not be possible to cover the small space of a "Museumtum" plot, and even those that succeed take very long to get spliced.

This peculiarity has been noticed in other crops too. Among the European orchard trees there exist certain species that are well-known to be admirably suited for purposes of grafting, while others that are always discarded for these purposes as being unsuitable and heavy. The same characteristic is noticed in Cinchona trees and also in Hevea, one parent tree of which often appears decidedly more suitable for taking buds and grafts from than others. A striking example of this same trait was once noticed by me some time ago. A colleague of mine had centered his attention on the breeding of Cassava and was busy planting out, propagating by means of cuttings. Of the cuttings obtained from one sort of parent there were some hundreds of plants while only about twenty plants from the cuttings of another existed. Although the latter plants gave such plentiful crops that the experimentor was induced to encourage the propagation of this sort on a large scale, it was not a success as cuttings of these plants did not strike on and grow as fast and as successfully as those of the other sort. And it is strange indeed that the two different parent plants used were planted out originally as cuttings from one tree. Again we are reminded by this of the fact I want to drive home : compare plants ungrafted or sown from seed only and great variations and mutations are noticed to occur, but compare plants propagated by vegetative selection from the same parent and the unique similarity is obvious.

After giving you an account of the benefits of grafting, I shall proceed to speak to you also on the points that can be urged against it. Before I do that I must sum up the points in its favour : the great uniformity on five points. Grafts of one parent tree possess those qualities superior to ungrafted ones : uniformity of shape and habit, uniformity of the quantity of crop produced, chronological uniformity, uniform characteristic of passing on to their progeny the quality of serving satisfactorily as parent trees, and the uniform appearance of the berries and beans.

(*To be continued*)

SOILS AND MANURES.

THE NEW NITROGENOUS FERTILISERS OF GREAT BRITAIN.

E. J. RUSSELL,

Director of the Rothamsted Experimental Station.

The new nitrogenous fertilisers were already known and studied to some extent in Great Britain even before the War, but they played no very great part in practical farming. In this there were two reasons. In the first place the British farmer relies very largely on livestock to supply his land with nitrogen. A large number of cattle, sheep and pigs are kept, and over most of the country the system of husbandry centres round the animals.

Before the War the following were the approximate quantities and values of the nitrogenous manures consumed in the United Kingdom:—

	Tons per annum	Estimated Value per annum Pre-War Prices.
Farmyard Manure	37,000,000	£11,000,000
Nitrate of Soda	80,000	920,000
Sulphate of Ammonia	60,000	750,000
Cyanamide and Nitrate of Lime	10,000	110,000

In addition to the farmyard manure large quantities of animal fertiliser are added annually to the soil by means of sheep folding, a common practice on loams, sandy and chalky soils, in which sheep are penned on the arable land, eat the growing crop and receive in addition quantities of corn and cake. No good estimate can be made of the quantities of nitrogen thus added, but in the aggregate they are considerable.

This factor continues to operate and it remains true that nitrogen reaches the farm soil largely through the animals.

A second cause of the comparatively small part played by the new nitrogenous fertilisers in British agriculture before the War lay in the fact that the country is well supplied with coal, and that various coal-using industries, notably Gas Works, Coke Ovens, Producer Gas Plants and others, take steps to recover the ammonia produced. To some extent the manufacture of sulphate of ammonia is only incidental to the main business. The manufacturers can hardly help making it; they cannot destroy the ammonia nor discharge it into the atmosphere or the streams without involving themselves in breaches of the Alkali and other Acts

When industry is going at full pace the normal output of 400,000 tons or so per annum becomes almost automatic. The result is that a large quantity of sulphate of ammonia is available on the British market, far in excess of what the farmer now uses, or indeed is likely to use in any time in which we are interested. Much was exported, very largely to the sugar-producing countries and to Japan for rice cultivation. The figures, in long

tons, were:—

	1909	1910	1911	1912	1913
Production	233,664	367,587	384,976	388,308	432,618
Export	162,300	284,976	292,000	287,000	325,000
Home consumption	71,700	87,000	85,500	90,000	97,000

The greater part of the home consumption was for agriculture, but not all as other industries, such as refrigerating, etc., took their share, though the demand for such purposes does not appear to be increasing. During the War the figures rose and they reached a maximum in 1917.

Since the War the production of sulphate of ammonia in this country has fallen off; the figures are:

	1917	1918	1919	1920
Production	458,617	432,551	397,513	418,881
Home consumption	384,000	404 500	285,500	233,500
Used for Fertiliser	230,000	234,000	269,000	

With a home production of sulphate of ammonia so far ahead of home requirements, and remembering also that the nitrate of soda industry is well organised in Great Britain, it is obvious that new nitrogenous fertilisers are likely to have some difficulty in establishing themselves on the British market.

There are, however, certain directions in which the new are able to compete successfully with the older fertilisers, and these will be considered under the various heads.

NITRATE OF LIME.

This substance has been tested at a large number of centres and has usually proved as effective as nitrate of soda; sometimes the one and sometimes the other has proved the better, but on an average the difference has been slight. The most extensive trials are those started before the War. Some typical results have been as follows:—

	Mangolds					
	1 Midland Agricultural College, Derby, 1915		Gloucester 2 Cirencester		3 Calcareous Soil	4 Reading 1909 Strong loam
	Light Soil	Heavy Soil	1909	1910		
	t. cwt.	t. cwt	t. cwt.	t. cwt.	t. cwt.	t. cwt.
Nitrate of Soda	29 8½	30 14	29 14	32 4	25 11	34 18
Nitrate of Lime	28 8	30 4½	32 5	30 3	25 11	35 1
No Nitrogenous top-dressing	20 10	25 18½	23 14	28 0	21 19	23 3

(1) *Midland Agricultural College, Derby, Reports*, 1915, p. 51, 1909 and 1910, p. 33.
(2) *Royal Agricultural College, Cirencester*, 1910.
(3) *Gloucester Country Council Reports*, 1909 and 1910, p. 74. Table I.
(4) *Reading University College, Department of Agriculture, Bulletin*, VII p. 11, 1909.

	Potatos				Barley		Wheat	
	(1) Woburn 1909 Sandy loam	(2) Devon Light Soil	(3) Jersey 5 centres	(4) Aberdeen Various centres 1907-1909	Rothamsted 1909		Rothamsted 1910	
	t. cwt.	t. cwt.	lb. per perch	t. cwt.	Grain bushels	Straw lb.	Grain bushels	Straw lb.
Nitrate of Soda	15 9	10 15	221	9 5	48·1	3882	27·0	3760
Nitrate of Lime	15 6	10 7	228	9 6	46·2	4449	20·7	3618
No Nitrogenous top-dressing	14 12	9 18	195	8 6	28·7	2619	15·4	1526

(1) *Journal of the Royal Agricultural Society*, London 1909, p. 385.

(2) *Devon Country Council Report*, 1907-1909, p. 6.

(3) *State of Jersey (U. S. A.) Field Experiments*, 1911, p. 2.

(4) *University of Aberdeen and North Scotland*, Leaflet 9, p. 2.

In practice nitrate of lime still suffers somewhat from the disadvantage that it is apt to turn sticky in a moist atmosphere and that it must be conveyed in casks, a fact which necessarily adds to the cost of transport. Further, it is not suitable for the mixed or "compound" fertilisers which are very popular in Great Britain. It has, however, the great advantage of containing calcium in place of sodium, and is therefore of value in two sets of conditions in England.

1.—On heavy soils, since it does not cause the deflocculation and therefore the stickiness or "unkindliness" to use the farmers' phrase, which is often brought about by nitrate of soda.

2.—On soils deficient in lime, of which there are large areas in England, particularly in the west, where the calcium, small though it be in quantity, nevertheless proves of high value.

In the writer's view there is a distinct future for nitrate of lime in Great Britain, not in supplanting, but in supplementing, nitrate of soda and sulphate of ammonia.

NITRATE OF AMMONIA.

This substance became available for British farmers immediately the War was over, although in anticipation of the event the Rothamsted Experimental Station had made enquiries and experiments as to its probable value as fertiliser. Next to urea it is by far the most concentrated nitrogenous fertiliser on the market. When pure it contains 35% of nitrogen, equivalent to 42½% of ammonia. Half of the nitrogen is in the form of nitrate which is immediately available for the needs of the crop, and the other half in the form of ammonia which comes into action somewhat later. Samples examined at Rothamsted have been about 96% pure, the remainder being mainly moisture: in this case the nitrogen content is 33½%.

Further, as the ammonia is combined in the form of nitrate it has no exhausting effect on the lime in the soil, so that it can be used where there is a shortage of lime and where, therefore, there is reason to believe that

sulphate of ammonia would not be wholly suitable. It is also entirely suitable for general farm crops and is perhaps the quickest-acting top-dressing known, being even more soluble than sodium nitrate, and at the same time, as part of its nitrogen is in the form of ammonia, it is not so liable to loss if wet weather sets in after it has been applied to the soil.

Like some other very soluble substances, ammonium nitrate is liable to attract moisture from the air, and some samples become unmanageable because they form a tough cake which cannot easily be broken and may become pasty. There are, however, several varieties or modifications of ammonium nitrate, and one of them is free from this objectionable property. It is obtained by recrystallising under special conditions. This non-deliquescent variety keeps quite well in a dry shed : some of it was stored in the manure shed at the Rothamsted farm for ten months without becoming unmanageable. But it is by no means clear that this result could always be obtained, or that sufficient of the non-deliquescent variety could with certainty be manufactured to meet the needs of farmers.

In the case of any fertiliser in England it is necessary to enquire how it would behave in admixture with others, partly because as already stated, farmers prefer to buy mixed or "compound" manures, and partly because, even when they buy the several substances themselves, they prefer to put them on altogether as far as possible, in order to save labour, a very serious item on British farms where wages are much higher than in many parts of the Continent. In the case of nitrate of ammonia this question would not usually arise, as the proper use of this substance is as a top-dressing.

It was found, however, that should the necessity arise, nitrate of ammonia would quite well mix with superphosphate so long as this material was dry and in good condition, but that if damp, noxious brown fumes were given off, as might be anticipated.

As a top-dressing it had the defect in some instances of scorching the leaves of the young plants, particularly in the drier and warmer parts of the country. At Rothamsted a crop of mangolds was injured in this way in 1914, the small crystals falling on the leaves yielded so strong a solution that the plant suffered considerably. In later experiments the material was applied in a fine interval during showery weather, with the result that it was speedily washed off the leaves and caused no damage at any time. In experiments in the North, where the conditions are moister and cooler, no bad effects were observed.

The results of the experiments showed that nitrate of ammonia behaved very like nitrate of soda for farm crops : for example, for mangolds it was more effective than sulphate of ammonia when reckoned on an equal nitrogen basis, probably, because part of its nitrogen is already in the form of nitrate; for wheat it is equally effective. For potatos, however, it is more risky than sulphate of ammonia : it gave as large a crop, but induced the formation of a large growth of haulm, which would be a disadvantage

wherever there was much blight. The results at Rothamsted have been :—

	Mangolds tons per acre	Potatos tons per acre	Wheat			
			Grain bushels per acre		Total produce including Straw. lb. per acre	
			Expt. 1	Expt. 2	Expt. 1	Expt. 2
Basal dressing :						
Nitrate of Ammonia (1)	23·3	8·8	44·7	37·7	8120	7830
Sulphate of Ammonia (1)	18·6	8·7	41·3	40·1	8180	7775
No nitrogen	17·3	8·0	38·6	34·6	7310	7025

(1) Equal quantities of nitrogen are applied on these plots.

As compared with nitrate of soda it has sometimes proved more effective. Thus in an extensive series of twelve experiments on hay land, carried out by HENDRICK at Aberdeen, during the years 1911-1914 the results were as follows :—

	Cwt. of hay per acre.
Basal dressing Nitrate of Ammonia (1)	56·2
,, ,, Nitrate of soda (1)	53·8
,, ,, No nitrogen	50·2

(1) Equal quantities of nitrogen are applied on these plots.

Similar results have been obtained with oats and also with mangolds. It is quite possible that nitrate of ammonia is really the most effective and most valuable nitrogenous manure we have. But as against this enormous advantage there is the serious risk of deliquescence, and until this is greatly reduced it is unlikely that nitrate of ammonia will find an important place in the market.

UREA.

Urea is the most concentrated of all nitrogen compounds offered to the farmer. It has not been the subject of many field experiments in England, but whenever tested as a fertiliser it has proved to be of the same order of value as sulphate of ammonia and nitrate of soda. The difference between these two fertilisers is in any case not very great. If the nitrogen in nitrate of soda is valued at 100 that of sulphate of ammonia is usually worth 96 to the farmer.

But in English farming it is always necessary to take account of possible harmful effects on the soil. Urea is singularly free from these ; it does not make heavy soil sticky as nitrate of soda does, nor does it remove lime from the soil as does sulphate of ammonia. The writer knows of no soils on which urea would be unsuitable. It mixes with practically every fertiliser and would cause a minimum of trouble to the manufacturer of mixed fertilisers and proprietary manures. Further, it does not wash out from the soil, but is retained probably as well as sulphate of ammonia, in which respect it is superior to nitrate of soda which in very wet districts, is liable to wash out.

So far as present evidence goes, and it seems quite sound, urea is more effective when drilled with the seed than when used as top-dressing. The

experimental results at Rothamsted have been :—

	Barley				Potatos (1) 1921
	1921		1922		
	Grain bushels per acre	Straw Cwt. per acre	Grain bushels per acre	Straw Cwt. per acre	tons per acre
Basal dressing :					
Urea	34·0	23·4	33·4	21·8	2·63
Sulphate of Ammonia	35·0	23·5	32·3	20·3	2·31
No nitrogen	26·1	17·6	25·2	16·8	2·00

(1) This crop almost failed because of the drought.

The high percentage of nitrogen in urea gives it a great advantage wherever transport is an important consideration. For the export trade, or for farms situated a long distance from rail or canal, or wherever a long railway journey has to be made, there is a considerable advantage in handling a manure containing 37 % of nitrogen as is the case with urea, rather than in handling one containing only about half this amount. Further, the freedom of urea from injurious secondary effects on the soil, to which reference has already been made, gives it special advantages wherever any such effects cause inconvenience to the farmer. If urea can be put on the English market at the same price per unit of nitrogen as sulphate of ammonia it will undoubtedly prove a serious competitor. Even if it remained somewhat dearer there still remain distinct possibilities for it in cases where the lime-removing effect of sulphate of ammonia could not satisfactorily be remedied, and where nitrate of soda was unsuitable, so long as the disparity of price was not too great.

AMMONIUM CHLORIDE.

For technical reasons ammonium chloride is one of the cheapest forms in which synthetic nitrogen can be put on the market.

On general grounds it would be supposed that the chloride and sulphate of ammonia must be of equal value as fertilisers. There is, however, much physiological evidence to the effect that the chloride under certain conditions may be harmful to plant growth. It by no means follows that this would happen in practice ; whether it would or not can be ascertained only by trial. In view of the technical importance of the salt an extended investigation is being made at Rothamsted and at various centres in England under Rothamsted supervision.

The investigation proceeds on two lines. Pot experiments are made to see whether the chlorine is exercising a harmful effect on the soil, or whether some of the soil constituents are mitigating, or even suppressing, the action.

Field experiments are made to discover to what extent field factors,—such as subsoil, varying water supply, or indirect effects of ammonium chloride on the soil itself—influence the action of the fertiliser.

The pot experiments show conclusively that the chlorine ion has no visible toxic effect on the plant in soil *when all conditions are favourable to growth.* The chlorine and the sulphate had at least equal value when compared on the basis of equal nitrogen content ; indeed in the light soil the chloride usually proved the better.

Field experiments gave varying results. In many cases the chlorine proved inferior to the sulphate, especially under rather dry conditions: in other cases there was no recognisable difference between the salts; while in a few cases the chloride appeared to give better results, than the sulphate. It may of course be the case that this apparent beneficial action is simply the usual "scattering" of field trial results; this will become clear when more data have accumulated. But when the results are set out in detail there is a distinct suggestion that, in certain conditions, the chloride does in fact give better results than the sulphate. What these are can as yet only be conjectured and it is more profitable to await the results of further experiments.

There is, however, one objection to ammonium chloride which in some conditions might prove serious as it appears to increase the risk of loss by drainage. This action is more harmful than that of ammonium sulphate which leads to loss of lime and consequent acidity, because in the case of the sulphate, the calcium compound is certainly not harmful to the growing plant, while calcium chloride is injurious. The harmful effect could no doubt be reduced to a minimum by proper attention to time and method of application, and indeed it is a possible cause of the occasional beneficial results that have been noted above.

The field results have varied with the season. The season 1921 was hot and very dry.

In this year the nitrogen in ammonium chloride had approximately the value of 90, when that in ammonium sulphate was put at 100.

The season 1922 was cold and wet. The nitrogen in ammonium chloride, when that of the ammonium sulphate was put at 100, had the following values:—

For potatos in 50 tests	... ...	99
For mangolds in 18 tests	... ...	98
For cereals in 2 tests: Grain	... ...	99
Straw	... ...	105

The result is so near to 100 that it might at first be supposed that the ammonium chloride was fully equal to ammonium sulphate as fertiliser. Closer examination of the figures shows, however, that one or two results step out very much from the average and raise the value above its true level. When a distribution curve is drawn it is clear that the peak comes somewhere about 96–99, and for the present it is better to take this figure rather than the crude average as expressing the value of nitrogen in ammonium chloride when that in ammonium sulphate is put at 100.

Some of the individual results are as low as 83–88; these are invariably obtained with potatos grown without dung and with kainit or potassium chloride. It is not usual to grow potatos without dung, but if for any reason this were being done, it would apparently be inadvisable to use ammonium and potassium chloride together as fertiliser.

It is at present difficult to say what future lies before ammonium chloride as fertiliser. Almost everything will turn on the price at which it can be sold: it is undoubtedly of great value to the farmer, and when its various effects on the soil and the plant have become better known it will be possible to set out the conditions under which it can be used to the maximum advantage.

CYANAMIDE.

It is perhaps hardly necessary to refer to cyanamide here since its direct action as fertiliser is not as good as that of the other substances to which reference has been made, and it can be converted by the manufacturer without great difficulty into one or other of them. There can be little doubt that this is the wisest procedure.—INTERNATIONAL REVIEW OF SCI. & PRAC. OF AGRIC., Vol I., No. 4.

BACTERIA WHICH BENEFIT AGRICULTURE.*

BY THE DIRECTOR OF AGRICULTURE, MADRAS.

It is not generally understood how many natural processes and fermentations are dependent on the presence of bacteria, and, further than that, the fact that certain kinds of bacteria do certain work which is not done by others. I therefore propose in this report to deal with some of those which more closely concern the agriculturist.

Even at the present day in this country it is by no means generally realised, firstly that such objects as bacteria exist at all, secondly that granting their existence, they are of many kinds and shapes and sizes, and thirdly that the work they accomplish is dependent on the type of bacteria performing it and that one type will not perform the work of another. I particularly wish to emphasize again the existence of these minute organisms and their enormous economic importance.

Some people seem to find extreme difficulty in grasping the fact that although large families, or what are technically known as "colonies," of bacteria can be easily seen by the naked eye, when grown or cultivated under special conditions, individuals can only be demonstrated by the use of advanced scientific technique. In other words, it is quite impossible to pick up a handful of soil and demonstrate to the ryot the bacteria running about and working in it.

They are not worms or insects, both of which belong to an infinitely higher and more organized branch of nature.

DIFFICULTY OF SEEING BACTERIA.

This initial difficulty being recognised it is at once a question—how are bacteria to be recognised and demonstrated to the general public? For the scientist his training and knowledge make this question a fairly easy one, but for the untrained person recognition and demonstration have to depend on the effects produced as the result of the presence of bacteria and the reverse, that these effects are not produced in the absence of bacteria.

It might be considered an easy matter to arrange demonstrations whereby people might be shown these tiny creatures through the scientific instrument known as a microscope; students are of course shown in this way after they have had considerable training in the use of apparatus. This method is not, however, generally applicable because a microscope is an exceedingly delicate instrument—very costly—and must be handled with extreme care as it is easily, irreparably damaged. It is possible to demonstrate bacteria by means of lantern slides, but again comes the difficulty of explaining that what is being shown to the naked eye in this way is thousands of times larger than the actual thing itself. In spite of all this, however, the fact remains that bacteria are of the most tremendous economic importance.

They are directly responsible for many human, animal and plant diseases, and they are essential factors in many industries such as the manufacture of lactic acid, vinegar, in tanning, sewage treatment, and dairying.

---

* Part of Digest No. 10, Department of Agriculture, Madras.

BACTERIA AND SOIL FERTILITY.

It is, however, the question of soil fertility which is of vital importance to the ryot and therefore the effect on this of the presence of bacteria and different kinds of bacteria is the point which most closely concerns him.

It was pointed out in the first report of this series that the numbers and kind of bacteria were of the greatest importance with regard to soil fertility.

In that report the main activities of beneficial soil bacteria were also dealt with and how these were encouraged to multiply and how the growth of harmful bacteria was to be eliminated as far as possible.

It is now proposed to go into a little more detail and explain the actual methods in use in bacteriological soil analysis and show how this may be regarded as an index of soil fertility.

First of all it is possible to estimate numbers of bacteria in a definite quantity of soil and the effects of varying conditions on these numbers can be ascertained.

For example the application of farmyard manure and green manure which is known to every one to be beneficial, result in an appreciable increase in the number of micro-organisms in the soil allowing for those actually added in the manure. If soil is subjected to prolonged drying the numbers of bacteria fall considerably but an increase at once follows subsequent moistening, and this again shows a connexion between plant growth and soil bacterial content. In fact the moisture content of the soil and the soil temperature can both be correlated with the numbers of micro-organisms present. In addition, the crop and the system of cropping have been shown to exert a direct influence upon the numbers of the bacterial population.

Earlier in this report it was stated that one method of recognizing the presence of bacteria was by the effect they produced. Some of these effects are increased oxidation in the soil and nitrate production and these together with crop yield can all be correlated with bacterial numbers.

Now, it was stated in the first report that the ryot knew that by bad cultivation good land can become poor and, now, begin to see some of the reasons for this.

BENEFIT OF LIME.

It has been shown that in land receiving ammonium sulphate as a manure and no lime that the crop yield was practically nil and the number of micro-organisms extraordinarily low. As soon as lime is added, the acidity, or soil sourness which was produced as the result of the manuring with ammonium sulphate alone, is reduced and both crops and bacterial numbers increase immediately.

With land which received no mineral or nitrogenous fertilizer continuous cropping so exhausts it that crop yields become negligible and at the same time the numbers of micro-organisms are extremely low.

Therefore, although the ryot may know that liming of acid soils results in increased crop he probably does not know that it also results in an enormous stimulation of the development of micro-organic life. If, however, he had applied to a bacteriologist for assistance the latter could at once have told him that liming was necessary for sour soils because otherwise the bacterial population would be too low in numbers to help in making the soil fertile.

Manure also has a similar stimulating effect. It is of course possible instead of estimating actual numbers of bacteria to make measurements of the actual chemical activities of the bacteria as stated above. These activities are dependent on the numbers of bacteria present and therefore can be correlated with soil fertility.—MYSORE ECO. JOURN., VOL. 9, NO. II.

PRESERVATION OF COW-DUNG, CATTLE URINE AND FARM-YARD MANURE.

S. N. MULLICK,

Mullick Agricultural Farm, Ranaghat.

Many farmers of Bengal do not know how to preserve cow-dung and cattle urine. They only know that cow-dung is a good manure but they are totally in the dark as to the manurial value of urine. There are, indeed, richer manurial matters in urine than in cow-dung, yet there is no provision for preserving urine for manurial purposes.

Farmers spoil urine in the cow shed. It is allowed to percolate down the floor of the shed and run to waste, with the result that the average farmer is deprived of the value of urine as manure while he has the fullest opportunity of enjoying its sweet odour for a pleasant length of time. The earth of the cow shed floor to a depth of 4 to 5 inches is generally very rich in manurial matters, which may be utilised in the following manner:—

Scatter dust thickly on the floor of the shed on every 5th day, the dust will soak up 90 per cent. of the urine. Then remove the 5 inches earth to be utilised for manurial purposes. Scatter dust again and repeat the operation. Thus about 90 per cent, of the urine may easily be preserved. This is the best as well as the easiest method of preserving urine and, as such, should be followed by every farmer.

In the Allahabad Agricultural College a good process of preserving urine and liquid manure is employed. They have two drains in the cow shed with two big pacca pits or cess-pools at the end (outside the shed).

All the urine and water of the shed accumulate in these pits and are collected and removed from time to time and applied to those plots where they are deemed necessary.

In this country there is no good arrangement for preserving cow-dung, even though the farmers do not know of any other manures to be used in their fields. They generally heap it up in and around the cow shed exposed to the action of the sun and rain, which makes it lose most of its manurial properties.

The best means of preserving cow-dung is to keep it covered in a pit so as to protect it against the sun and rain. The man in charge of the cow shed should bring cow-dung along with other refuse matters to the pit and with the help of a hoe stir it and bury it. Cow-dung plaster should be applied to the bottom and the walls of the pit so that no aqueous portion of the manure can percolate in any direction. When the first pit is filled up, another should be dug and earth should be scattered on the first pit so that no watery portion of the decomposed manure can be evaporated. In this way cow-dung may be kept for a long time in good condition.

It is not advisable to mix fresh cow dung with rotten cow dung, which has already become manure.

The attention of the farmers of Bengal is drawn to the manurial value of cow-dung and cattle urine which may be profitably utilised with but little care. This utilisation is also preferable in the interests of sanitation and public health in-as-much as the unbearable obnoxious odour of decomposed cow-dung and cattle urine, which is the result of careless accumulation or unsystematic scattering, may be avoided or minimised. There is thus the double advantage of utilising them.—INDIAN SCIENTIFIC AGRICULTURIST, Vol. 4, No. 9.

PESTS AND DISEASES.

THE CEYLON MOLE RAT.

GUNOMYS GRACILIS.

W. W. A. PHILLIPS, F.Z.S.,

St. George, Matugama.

One of the great pests with which the paddy cultivator has to compete in Ceylon, is the Ceylon mole rat (*Gunomys gracilis*).

More generally called the paddy field rat—the wel-miya of the Goiya—the kurumb-elli or vaiil-elli of the Tamils—this rat is very closely allied to the *Gunomys bengalensis* of India and has habits somewhat akin.

It is found, commonly, either in the paddy-fields or in the gardens of the villagers and in many parts subsists practically entirely upon the fruits of his labours; doing very considerably more damage than is generally realised.

Description.—Although well known in most parts of the country, before proceeding to give an account of the habits of this Rodent, it will be well to give a short description of its appearance, so that there may be no possibility of confusing it with any other rat. In general form it is rat-like, coarse-looking and heavily built, and is not unlike a small bandicoot, to which species it is closely allied. The head is rather blunt and broad and the tail is shorter than the body.

The limbs are short and stout with the feet equipped with strong claws for digging. The fur is grey brown to dark brown on the upper parts, with a number of longish dark piles—found only in the adults—scattered over the back ; the underparts are lighter grey.

In the case of the young, the general colour is more of a bluish grey with little dark brown on the back and no long piles in the fur.

Measurements.—The average measurements are as follows : head and body 175 mm (1·7 ins.) ; tail 150 mm. (6 ins) ; ear 20 mm. (85 ins.) ; hind foot 33 mm (1·32 ins) ; weight to about 8 ozs.

The female is generally smaller than the male, but sometimes only very slightly so.

Distribution.—Though the whole of Ceylon has not yet been worked, it seems probable that this rat is found locally distributed over practically the centre low-country—wherever the cultivation is sufficient to enable it to find its food without difficulty. It is, however, generally much more abundant in the wet zone, where the soil is always sufficiently soft for it to drive its galleries through the bunds and banks of the paddy-fields. In the hills it is found in the paddy fields of the Kandy district and is said to be common up to 2,000 ft. The species is peculiar to Ceylon, though closely related to the South Indian form.

Habits.—The Ceylon mole rat, though only very distantly related to the true mole rats (Family Spadacidæ), gains its name from its habit of burrowing into banks and paddy field bunds and throwing up heaps of earth which often bear a great resemblance to the hills thrown up by the mole.

It will drive a gallery 20 yards or more along the centre of a narrow bund, throwing out the excavated earth at intervals, often without revealing

the side gallery or hole out of which the earth has been thrown, and often without showing any very obvious opening to the main burrow. In this burrow it will live from the time the paddy field is sown and has the water let out of it, until the return of the wet weather, when the fields are flooded again ; and in this burrow it produces its young.

As far as my observations go, each burrow is made by, and inhabited by, one adult only and (in the case of the female) its progeny when they are old enough to move about.

The male is usually solitary and has its own burrow, but sometimes a pair and their young may be found together.

The burrow is dug along the length of a narrow bund between two paddy fields. A main gallery generally leads for many yards along the centre of the bund, with short side galleries leading from off it, which are used both as a means of getting rid of the excavated earth and as subsidiary exits—but which are generally kept closed with plugs of loose earth. In the main drive are the store chambers and the breeding chamber, for this rat is a provident animal and stores up large quantities of grain against times of scarcity.

The store rooms are merely circular chambers hollowed out in the middle of the main drive and are usually not far from the living or breeding chamber. There are usually at least two and sometimes three or four, which are all packed with paddy, still in the ear, by the end of the paddy harvest. Apparently the rat leaves its burrow at night (for it seems to be purely nocturnal in its movements) and nibbles down the ripe paddy, biting off the straw just below the ear and carrying the latter off to its store rooms.

In digging out a burrow I have known a cooly fill his cloth with the recovered grain from the several store chambers ; and BLANFORD, writing on the Indian mole rat (*Gunomys bengalensis*) in his " Mammalia," quotes ELLIOTT as saying that "the Wadaries or tank diggers of the Deccan, who eat all rats, in some favourable localities are able, at particular seasons, to subsist on its hoards of grain."

Unfortunately it is one of the most prolific of rats—the female generally producing a family of 10 to 12 young. These are born in the breeding chamber, which is circular like those used as store rooms, but is generally lined with paddy straw or dead leaves and, when possible, is placed beneath a stump or the roots of some small bush growing on the bund.

The young are born blind and naked but grow rapidly and the majority of them seem to leave the home-burrow when a quarter or half grown. They may then be found either in short burrows of their own or very often beneath heaps of paddy straw left lying near the thrashing floors, under which they construct a net-work of runs an inch or two below the surface of the damp soil.

When the water is let into the paddy fields again, preparatory to re-cultivation, the mole rat generally leaves the fields and retires either to the higher banks where it lives on grass-roots or rubber seeds, etc., or to the villagers' gardens, where it proceeds to carry on its depredations. It is usually found then, burrowing among and living upon the sweet potatos and yams and doing much damage generally to garden produce.

Owing to its habit of living so much below ground it is not an animal that can be trapped very readily, but sometimes it may be taken in an ordinary gin baited with coconut. But the most efficient method of dealing with it, when it becomes too great a pest, is to systematically dig out its burrow in the field bunds, immediately the paddy crop has been harvested —when not only may the rats be destroyed but the grain that they have hoarded may be recovered.

PROTECTION OF CABBAGE AND KNOLKHOL SEEDLINGS FROM FLEA-BEETLES.

P. V. WAGLE, B. Ag.

Entomological Assistant, Konkan.

The growing of vegetables for the market, and particularly the cultivation of cabbage, knolkhol and other similar plants, is beset with many difficulties, but there are few which are more annoying and injurious than the way in which the young seedlings are destroyed in the seed-beds by several insects, of which by far the most important are the flea-beetles. The present note deals with experiments made in the Konkan near Bombay to check the damage from these and similar pests.

The flea-beetles are small bluish-coloured beetles, which, being furnished with powerful hind-legs, jump when disturbed almost as vigorously as fleas, from which faculty their name is derived. There appear to be many species of these in India, but most of them have not been identified, and about their life-history little is known. As the seedlings of many vegetables grow these beetles are often found in multitudes feeding on the leaves and leaving behind them numerous small round holes. The tender seedlings so attacked generally die.

The measures previously adopted against these and similar seedling pests have chiefly consisted in collection of the insects by hand, spraying with kerosene emulsion and dusting of the plants with ashes previously treated with kerosene. Such remedies were tried in the present experiments but, when the pest was bad, none of them was satisfactory. Spraying and dusting of seedlings in seed-beds is in any case not very satisfactory as the frequent necessary watering tends to remove the materials from the leaves. When the insects are present in large numbers, collecting by hand or bag proved almost impracticable.

Two new methods were therefore tried. As the area of seedlings is usually small, it was suggested that the whole of the seedling area should be enclosed by a fine-meshed curtain like a mosquito net. Two seed-beds, each three feet square, were prepared and sown with knolkhol seed. One was completely protected by a curtain as described fixed on a bamboo frame and about eighteen inches high. The lower sides of the curtain were weighed down with stones. The net was easily removed for watering and was then immediately replaced. The result was excellent. No attack took place, while in a similar seed-bed without protection the plants were miserable, stunted and several times smaller than those inside the net. The inevitable interference with the light inside the net did not seem to have any serious effect on the character of the seedlings after transplanting.

The second method tried was by trapping the flea-beetle on a sticky plate. It was suggested by the success which had been obtained in trapping mango-hoppers on trees by means of a sticky mixture of oil and resin. A rectangular tin plate, two feet long and eighteen inches wide, with a handle at the back for holding, was used in the present experiment. This was painted on the lower side with a sticky mixture prepared from boiled *undi* oil (*Calophyllum inophyllum*) (1 part) and fairly powdered resin ($2\frac{1}{2}$ parts). Any other similar oil would probably have given the same results, but the proportion of resin necessary to keep the mixture sticky would have to be worked out in each case. The tin plate so prepared is held over the infested seed-bed, and the plants gently brushed. The insects when disturbed fly up and are caught on the sticky tin plate. If this brushing is repeated on four or five successive days, the infestation can be almost entirely removed. If necessary, it can, of course, be continued longer. After three or four

days, the sticky mixture dries up, but a few minutes' exposure to the sun will make it as sticky and effective as before. The experiments with this method turned out a complete success and the damage by flea-beetle was reduced to very small dimensions.

In actually carrying out the first of the methods above suggested, a kind of coarse woven cloth, locally available in the market, was found to be satisfactory. A piece ten feet long and thirty inches broad cost about a rupee. Three such pieces will cover a seed-bed covering forty square feet, the cost for making the complete net being only eight annas. Thus at a cost of Rs. 3-8-0 a seed-bed will be protected sufficient to plant out one-eighth of an acre and the curtains will last for four or five years. This will save an annual large loss in these expensive vegetable seeds, with a guarantee that the seedlings will be ready when wanted.

The second method will only cost eight annas for making the tin plate with four annas for the mixture. By the use of this it is possible to clear seed-beds sufficient to plant out one acre of cabbage or knolkhol.—AGRIC. JOURN. OF INDIA, Vol. XIX., Pt. I.

ERADICATION OF THE SENSITIVE PLANT.

(*MIMOSA PUDICA.*)

K. J. ALEX. SYLVA,

Assistant Curator, Henaratgoda Botanic Gardens.

The sensitive plant (*Mimosa pudica*), which belongs to the natural order Leguminosea, was till recently cultivated in coconut estates as a cover crop. Unfortunately it has in recent years made its appearance in areas where it is not wanted, especially in lawns and cultivated gardens. Its eradication is a problem which now confronts the gardener both in the low country and at higher elevations.

The usual practice among gardeners is to use the mamoty in their efforts to eradicate the plant. The great drawback in the use of the mamoty is that it clears a small area around the plant. This helps the seeds which lie scattered around the parent plant to germinate and make a vigorous growth. The other disadvantage in the use of the mamoty is that it cuts off only that portion of the plant which is above ground but leaves the root-stock uninjured.

That the seed of the sensitive plant can remain in the soil for very long periods without losing its germinative power is a fact well known to gardeners. By weeding alone it is impossible to completely eradicate the plant.

The use of a strip of bamboo 28" x 2" x ½", with one end forked, has proved very useful in eradicating this obnoxious weed. The forked end of the bamboo strip is inserted near the root of the plant and twisted until the plant is uprooted bodily. This operation does not leave any part of the root stock in the soil; neither does it help the seeds in the soil to germinate and make their appearance above ground. The experience at Henaratgoda Garden is that if the above method is adopted it is possible to get rid of the plant from lawns in a very short time.

AGRICULTURAL EDUCATION.

AIMS AND WORK OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, WEST INDIES.

SIR FRANCIS WATTS, K.C.M.G., D. Sc.

It is generally recognised that the practice of agriculture has been considerably advanced during recent years by the more systematic training of those engaged in it. This improved training has come through various agencies, such as Agricultural Colleges and the inclusion of Agricultural Education in the course of study of a great number of the Universities; much has also been done through the influence of Institutes for Agricultural Research, Experiment Stations, Agricultural Societies and kindred organisations. The activities of the latter agencies have made evident the value of the systematic instruction given in the Universities and Colleges, for it has become apparent that a sound basis of scientific knowledge best assures progress and good practical work; hence the Agricultural Colleges and the agricultural courses in the Universities are being made more and more frequented by those who intend to engage in agricultural work as a means of livelihood.

These developments have led to demands for training in relation to tropical agriculture and this demand is accentuated by the increasing importance of the tropics as the sources of supply of commodities which have become essential to the daily life and industry of the vast communities living in temperate regions.

The special conditions attending agricultural work in the tropics and the nature of the crops grown, make it essential for those engaged in tropical agriculture to acquire the requisite skill and experience within the tropics themselves and in intimate contact with tropical crops and conditions. But hitherto few institutions have existed where a student could acquire systematic instruction in matters relating to tropical agriculture; most of those engaged in producing within the tropics those important commodities such as sugar, cotton, cacao, tea, rubber which supply the world's markets have had to acquire their knowledge and experience on the plantations, much as the farmers of temperate regions were obliged to do in former days; they too are beginning to enquire why facilities such as are so advantageous to farmers of temperate regions which are receiving increasing recognition at their hands, should not be available in regard to tropical work.

It is with the object of providing education and guidance of the kind asked for in relation to tropical affairs that the Imperial College of Tropica Agriculture has been established.

The College, which has now entered upon its second year, carries on its work in several directions. As its prospectus states, its object is to afford general instruction in tropical agriculture, to give opportunities

or thorough training in the science and practice of the subject, to those intending to become tropical planters, investigators or experts in different branches of agricultural science or technology, and at the same time to provide facilities for the study of tropical agricultural subjects on the part of graduates from other Universities and Colleges who desire to acquire knowledge of these subjects in tropical surroundings. To this end the College offers a three years' course in general agriculture, leading to a Diploma ; it affords facilities for study of particular subjects on the part of post-graduate students and it is prepared to afford facilities for research.

The three years' Diploma course is of a broad general nature intended to afford a sound basis of education in agricultural matters. At the same time special attention is given to the methods of growing, handling and marketing the more important tropical crops,the cultivation of the soil under tropical conditions and the many special problems connected therewith. the management of labour, the general equipment and management of plantations, and, in a general sense, to give a man a good all-round training.

It is obvious that a three years' course of instruction cannot provide the intimate experience acquired by long years of work on a plantation and cannot turn out managers of plantations of full experience, but it can give those entering upon agricultural work a better start and provide young men who should prove of more value to employers than untrained men who have to acquire their training while carrying out routine duties.

In the second and third year of the course the work is differentiated to meet the needs of those requiring training in regard to particular sciences and industries; thus, after the preliminary training in scientific fundamentals, the students are given opportunities of specialising in regard to various aspects of such crops as sugar, cacao, coconuts, bananas, various fruit crops, rubber and a variety of others, care being taken to develop a wide outlook at this stage.

In addition to affording a groundwork for study on the part of those expecting to engage in general plantation work, the three years' course should afford a good general training for those who wish to obtain appointments in the various Agricultural Department which now exist throughout the tropics, and it is hoped that these Departments will co-operate with the College by informing it of their requirements so that any special lines of work may be given attention.

The general course is calculated to be a useful and sound training for those who desire, by continuation of their studies, to become qualified to undertake duties in professional work, such as plant pathology, entomology, mycology, agricultural chemistry, plant breeding; a combination of general and post-graduate studies at the College offers unusual opportunities and facilities for acquiring this training.

The opportunities for post-graduate study call for special mention. Situated as the College is, within the tropics, in an island which has many of the features of the South American Continent, which it closely adjoins, and in intimate touch with an unusual variety of tropical industries, the College offers admirable opportunities for giving instruction to post-graduate students in connection with specific industries, particularly the production of sugar, cacao, coconuts, cotton, fruit and food crops and many others and also for studies embracing botanical, mycological, entomological, chemical and other interests, either in relation to industries, or in the direction of abstract scientific investigation.—TROPICAL AGRICULTURE, Vol. I., No. I.

INDIAN DIPLOMA IN DAIRYING.

The following press communique, dated 13th November, 1923, has been issued by the Government of India (Department of Education, Health and Lands) :—

The Government of India have decided, in connection with the working of the Imperial Institute of Animal Husbandry and Dairying at Bangalore, to institute an Indian Diploma in Dairying on the lines of the British National Diploma in Dairying, to be granted to persons who have successfully completed a course of not less than two years' instruction at an institute recognized by the Imperial Institute as capable of teaching up to the standard required for such a diploma.

It is hoped that sooner or later Agricultural Colleges in India will possess the necessary staff and equipment and will be willing to train pupils for this diploma, but, for the present, the necessary course of instruction will be commenced on January 1st, 1924, at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, where eight selected pupils will be taken.

The course will last for two years with two months' vacation each year. The holiday period will be the months of April and May.

The course will consist of practical and scientific training in the principles of cattle-breeding, cattle feeding and management, Indian and foreign breeds of dairy cattle, stock judging, diseases of dairy cattle, dairy farm buildings, milk production, handling and sale, butter and *ghee*. manufacture, dairy chemistry, dairy bacteriology and dairy farm book-keeping. Ample scope is available for practical and laboratory work at Bangalore. The practical instruction will be under the direction of the Imperial Dairy Expert and the scientific training will be carried out under the control of the Physiological Chemist to the Government of India.

Students must be of good character and over 17 years of age. The minimum educational qualification necessary for admission is the Matriculation or the School Final Examination, but, in special cases, the Imperial Dairy Expert will have power to waive this condition.

A tuition fee of Rs. 15.00 will be charged from each student for each month or part of a month he is actually in residence at the Institute. Accommodation will be provided free of charge which pupils must avail themselves of. No stipends will be paid to students and travelling expenses must be borne by students themselves.

At the close of the course an examination will be held for those students who have satisfactorily completed the course of instruction, and the Indian Diploma in Dairying will be awarded by the Imperial Institute of Animal Husbandry and Dairying to successful candidates.—AGRIC. JOURN. OF INDIA, Vol. XIX., Pt. I.

CEYLON AGRICULTURE.

MINUTES OF MEETING OF NUWARA ELIYA DISTRICT AGRICULTURAL COMMITTEE.

Minutes of a meeting of the Nuwara Eliya District Agricultural Committee held at the Kachcheri on the 26th January, 1924.

Present:—Mr. E. T. Dyson, Asst. Govt. Agent (in the Chair), Mr. G. G. Auchinleck, Vice-Chairman and the following members:—Messrs. J. S. Armstrong, P. B. Andarawewa, J. W. Bennett, C. J. Dewhurst, E. C. Elliott, J. A. Girihagama, D. C. Jayawardena, U. B. Unamboowe, T. B. Wattewe and C. C. Wilson.

1. Minutes of a meeting held on the 18th August, 1923, were read and confirmed.

2. MR. C. C. WILSON proposed that the Hon'ble the Director of Agriculture be asked to open a ten-acre experimental block of cotton in Walapane on the lines on which the experiment was carried out at Hambantota and that adequate arrangements be made for the distribution of seed to villagers and for the purchase of their crops. The proposal was seconded by MR. J. S. ARMSTRONG and carried unanimously.

3. The Divisional Agricultural Officer explained results of cotton trials at Nalanda experimental station, Matale, and results of sunnhemp trials at the same station.

4. Papers re the following were tabled :—

(a) Allocations made by the Hon. the Director of Agriculture for shows

(b) Agricultural Shows and Competitions 1923-24 and

(c) Kandy District Agricultural Shows and Competitions.

5. Resolved that the Hon. the Director of Agriculture be asked to provide, in addition to monies provided for other competitions in 1924-25, a sum of Rs. 100/- for a tea garden competition in Kotmale for gardens of 2 acres and under to be run on the lines adopted for the competitions in Uda Nuwara.

6. Resolved unanimously, on the motion of the Ratemahatmaya, Uda Hewaheta, to bring to the notice of Government the desirability of restoring the Bodi Ela and Waduwawala Ela as early as possible.

7. The Ratemahatmaya explained what steps are being taken by the Uda Hewaheta Co-operative Credit Society to establish a paddy bank.

8. The motion standing in the name of MUDALIYAR EDIRISINGHE "that with the object of increasing the Colony's food supply and in order to obviate the delay in carrying out schemes and proposals for restoration and construction of irrigation works, there should be more co-operation and co-ordination between the three departments most interested in Agriculture, *i.e.*, the Irrigation, the Agricultural and the Revenue Departments" was postponed for the next meeting owing to the absence of the Mudaliyar.

CO-OPERATION.

CO-OPERATIVE MARKETING IN THE UNITED STATES OF AMERICA.

Recent developments in co-operative marketing in the United States seem to mark an epoch in agricultural organisation. As in other countries the movement has passed through an experimental stage, a period of trial and error, out of which it now seems to have emerged with certain definite principles which are the direct result of practical experience. During the past few years, the progress has been most striking, and it is hardly too much to say that co-operative marketing is at the present moment the dominant movement in American agriculture.

Co-operative marketing in the United States started with dairy produce in the early part of the 19th century. It passed through a phase when it formed part of what was known as the "Grange Movement" founded in 1867, and the period between that year and 1880 saw the rise and fall of innumerable co-operative enterprises engaged in the marketing of grain, cotton, livestock, tobacco, wool and other produce. A failure to meet the real economic needs of agriculture, combined with radical mismanagement, brought this movement to sudden collapse, just as in Europe the application of the "Rochdale" principles to the marketing of farm produce—*i.e.*, the marketing of a large number of agricultural products through one association—led to an almost equally conspicuous failure.

Governing Principles.—In its subsequent development, there have by degrees become recognised certain governing principles which may briefly be summarised as follows :—

1. The organisation of sale must be on a "commodity" basis and not by locality, that is to say, whilst there must be local organisation for receiving, packing and grading, the organisation as a whole must cover a wide producing area, and the local units must be federated in one central body in order to secure adequate control of the market.

2. The supply of produce must be regulated by binding contracts under which the growers pledge their produce to the association for a term of years.

3. The products must be pooled according to size, grade or other characteristic, so that whilst individual growers obtain returns in proportion to the amount and quality of their produce, the organisation of sale passes from these thousands of individual growers into the hands of one organised unit.

How these principles came to be evolved may be illustrated by examples from what actually occurred.

1.—Growers of citrus fruit (mainly oranges) were among the pioneers of the American co-operative marketing movement. The first attempt at co-operation in this trade dates back to the early days of commercial orange

production on the Pacific Coast. Between 1877 and 1890 there was a very rapid development in the orange trade in California which soon resulted in "over-production"—there was a "boom" which was speedily followed by a general fall in prices. After an abortive attempt at self-protection through the agency of the Orange Growers' Protective Union, the growers turned to co-operation. The actual beginning was marked by the organisation of the Pachaffa Orange Growers' Association in 1888. Other local associations quickly sprang up, and succeeded in securing fairly good prices in the years immediately following, and during the early 'nineties.' They were, however, hardly more than local marketing agencies disposing of their members' fruit in each district independently.

The next step was the establishment of district exchanges in each of the chief producing areas operating in conjunction with the local growers' associations. The organisation of local associations and district exchanges, however, was not enough. It gave the growers no real control over the marketing of the fruit, the associations competed against one another, and the market still tended to be flooded at the time of harvest, and prices to be depressed. Growers therefore sought to federate the local associations into one central body, and ultimately, in 1905, the Californian Fruit Growers' Exchange, the central marketing authority for the united organisation, was established. Thus the last link in the chain came to be formed; federation proved to be the way to success, and with the advent of the California Fruit Growers' Exchange the co-operative organisation for the first time obtained a commanding position in the market. This exchange has dominated the market practically since its inception, and with its formation the general structure of the marketing organisation, viz., local associations—district exchange—central exchange, was complete. Upon this pattern the whole organisation as it exists to-day has been built up. At present there are 10,700 growers each contracting to deliver the whole of his fruit to the local association. There are 206 local associations concerned primarily with grading and packing, 19 district exchanges whose chief function is directing the fruit received from the local association to the markets, and finally the central co-ordinating body, the California Fruit Growers' Exchange. Upon the latter by reasons of its commanding position falls the task of controlling distribution, of preventing congestion, and thus of securing to the grower what is the real achievement of co-operative organisation—an established market.

2.—The second of the principles referred to above, viz., long-term producers' contracts, was evolved largely as a measure of self-protection. Many co-operative enterprises had in the earlier stages of their existence to withstand attacks from private dealers who endeavoured to tempt producers out of the co-operative organisation by offering high prices for their produce. It was precisely this difficulty which confronted the Danish co-operative movement in its earlier years, in fact, the long-period producers' contract applied to co operative marketing, is a Danish invention, from which country it was adopted by the United States. Producers' contracts were first used in America by a Farmers' Elevator Co. in Iowa in 1889; they were adopted by the California orange trade in the early 'nineties, and at the present time have become almost the only practice of co-operative undertakings in that country.

The advantage of the contract system, however, is not confined to eliminating the disruptive attacks of outside dealers. It also adds greatly to the power of the co-operative organisation to control the markets, since the volume of produce to be handled is fixed within comparatively narrow limits, thus enabling the marketing policy to be developed with a fairly definite knowledge not only of the present but of the future supplies of fruit to be handled.

3.—The principle of "pooling" has, with a few exceptions, also become the recognised practice of American co-operative marketing associations. Here again its adoption has been the outcome of practical experience. It has been found that it both cheapens the operations of grading and packing, and enables an association to establish a reputation for its products in the market, to reduce wastage to a minimum, and to handle the various grades more easily. Pooling usually consists not merely in the physical mixing together of the growers' produce according to grades, but in the transfer of the control of sale combined with a proper distribution of the profits realised amongst the members of the association. It greatly facilitates, indeed it is essential to, the exercise of the association's full powers of control over the movement of produce to the market, and it has consequently come to be recognised as one of the primary instruments of market stabilisation. Pooling in this sense is not, however, invariable.

Economic Difficulties.—With co-operation established on these guiding principles, American agriculturists have sought to apply it on a wider scale, in remedying the specific economic difficulties which beset the marketing of agricultural produce. These are principally three in number: (1) Seasonal fluctuations in prices; (2) Fluctuations in prices due to temporary excess of supply over demand, *i.e.*, in consequence of exceptionally heavy crops; and (3) Wastage due to deterioration.

In order to overcome these difficulties, the recent development of the co-operative marketing movement has aimed not merely at eliminating the middleman and replacing him by a co-operative society—the advantage of which to the farmer is at best small, and often negligible—but rather at putting into the farmer's hands an effective instrument by which he can prevent or at least minimise violent fluctuations in prices.

That the seasonal drop in prices at harvest time is largely due to financial causes (*i.e.*, to the farmers' need for ready cash) is well recognised. In the United States it has been estimated that only 12 per cent. of the farmers are able to finance their own crop raising. Consequently the practice of unloading their produce on the market at the earliest opportunity, both in order to raise money to meet their current obligations and to provide for subsequent operations, has been widespread amongst growers in every branch of agriculture. Of the cotton crop 70 per cent. is said to be dumped on the market by farmers during the period, September-December, and 65 per cent. of the wheat is marketed between the beginning of August and the end of November.

The farmer's need to raise cash on his produce lies at the root of the whole question; it is from one point of view the crux of the marketing problem, and it is because in the past—in a system of un-organised competitive marketing—he had no course open to him but to sell his produce outright

for what it would fetch, that he remained a helpless victim of the seasonal slump in prices which not infrequently fell below the cost of production.

Control of Produce and Bank Credits.—To meet these difficulties American co-operators have primarily endeavoured to secure two things: (1) the physical control of the movement of produce to market on the lines which have been described above, to an extent which gave the co-operative organisation a predominant position in the market; and (2) power to obtain bank advances by using the commodities themselves as collateral security. In practice this has involved an intermediate stage between the producer and the consumer in which the product is put into store—in the case of certain perishables into cold storage, and in the case of non-perishables into warehouses or other stores. Upon warehouse receipts the banks have been ready to make advances to co-operative marketing associations, on the same lines as has for many years been their practice in the case of wheat stored in elevators and cotton in warehouses. The association is thereby enabled to make an immediate advance to the growers—up to 50 or 60 per cent. of the market price—and still to retain control of the rate at which the produce is moved to the market. The development of this side of marketing operations has led to a considerable extension of the use of credit as a means of securing stabilisation of prices, and in the crisis which followed the general slump in prices in 1920 this machinery proved to be of the highest importance.

In 1922, the War Finance Corporation, a State credit institution with a capital of $500,000,000 created and guaranteed by the United States Government, was resuscitated, largely for the purpose of assisting agriculture over the crisis. During the season 1921-22 the Corporation authorised loans amounting to $64,000,000 to co-operative marketing associations, and in the following season similar loans were approved to the extent of $114,000,000 "to assist in the orderly marketing of the 1922 crops."

One quotation may be given from the annual report of the War Finance Corporation for the year ending 30th November, 1922, to illustrate the effect of these operations.

"In the midst of the worst depression that the cotton industry has suffered in many years it was through the co-operative marketing associations that the War Finance Corporation developed plans for extending assistance to the industry on a comprehensive scale. In the summer of 1921 when.....business throughout the Cotton Belt was in a demoralised condition, the corporation made its first loan to an association in Mississippi on 100,000 bales of cotton. The cotton was classified by the association according to grade and staple, and placed in bonded warehouses ..... The loan enabled the association not only to make advances to its members for their urgent financial needs, but also to market the crop through a greater portion of the consuming year, instead of forcing it on a demoralised market."

Co-operative marketing plus State credit, proved in the period of crisis to be a means of stabilising the market, of preventing panic, and of restoring confidence, which was of almost incalculable benefit to farmers, and as a direct consequence of its success, a new impetus was given to the co-operative movement itself under which many new marketing associations were organised for handling cotton, wheat, tobacco, rice and other staple products.

Turning to the other aspect of the question—the control of the physical movement of produce to the market, the most significant development in this direction has occurred in the case of perishables. In these organisations where the development towards federation has reached the point of giving them a dominating position in the market, control of the movement of produce has become a systematised practice. Although production necessarily varies with seasonal conditions, it has become possible, through co-operative enterprise, to secure that the rate of delivery to market is determined by the demand of the market and no longer by the rate of production. Thus, in the case of butter and cheese the rate of production rises during the first half of the year to a maximum in June and thereafter declines to a low point in December, whilst the rate of consumption is relatively steadier throughout. From about the middle of April to the end of August there is consequently a definite "into storage" period during which the association receives from producers more than it sells, and from the beginning of September till the middle of April an "out of storage" period during which these conditions are reversed. Thus the market is supplied according to its needs and fluctuation in prices is reduced to a minimum.

Marketing of Wheat.—In recent months much attention has been directed by American agriculturists to what is perhaps the greatest marketing problem in the world—that of wheat. Both on account of the widespread depression of wheat prices and of the predominant importance of wheat amongst the agricultural products of the United States the present position in regard to the problem of orderly marketing of the wheat crop of America is one of exceptional significance. The marketing of wheat in the United States is a highly organised business. The system of bulk handling, storage in elevators, and bank credits, combined with highly skilled technical management, has led to an organisation in some respects without parallel in the world. It is, however, not an organisation built up on the principles which American agriculturists have now come to know as "orderly marketing"; it does not embody those elements by which alone stability of prices can be secured. Fundamentally the wheat organisation has been developed round the "speculator"—the person who buys from the farmer at harvest time when the grain comes into the market in a greater volume than the current consumptive needs, and sells it again after the flood is over. To the speculator fluctuations in price are not necessarily an evil and may be a source of considerable profit.

The movement for the co-operative ownership by farmers of grain elevators has in the past years undergone considerable development, but its success has necessarily been only a partial one. It has enabled farmer members to obtain credit on their produce, and to this extent has rendered an important service, but it has not achieved its ultimate object. The flow of grain to market still continues in a disorderly fashion and prices tend to fluctuate as widely as ever. The bulk of the crop is still sold by farmers soon after harvest, and the farmer has to be content with what he can get.

The continued depression in wheat-growing districts and the increasing political pressure which was being brought to bear on the United States Administration recently led the President to appoint a Commission consisting of MR. EUGENE MEYER, Jnr., and MR. FRANK MONDELL, of the War Finance Corporation, to investigate the wheat situation. The Commissioner examined various proposals, and their conclusion is significant:

"Co-operative marketing associations organised along sound lines and with competent management and business guidance, offer at the present time in our opinion, more promise of helpful results than any other plan or programme that has been suggested. They can do what the speculator cannot with safety be relied upon to do. They can by orderly marketing regulate the flow of wheat so that supply is adjusted from time to time to the consumptive demand."*

Co-operation is daily becoming more widely recognised in America as the cure for fluctuations in wheat price. What has been wrong is partly that the principles of co-operative marketing have not been strictly applied in the case of grain, and partly that the practical difficulties are greater than in other branches of agriculture. With greater knowledge of the economic conditions of grain marketing, however, there would seem every reason to believe that these difficulties will eventually be overcome. The progress of organisation of wheat marketing in the United States during the next few years cannot but form one of the most interesting, possibly one of the most far reaching, experiments in co-operation in any country in the world.

Co-operative Marketing of other Produce.—It would be beyond the scope of this article to describe how these principles have been applied in other branches of agriculture, but there is no doubt that the success of the co-operative marketing movement† during the critical period of 1920-1922 has been the reason of its subsequent very rapid growth. In 1922 the turnover of American co operative marketing enterprises exceeded one thousand million dollars—a-five-fold increase within a decade. Most of the principal farms products are now successfully marketed through co-operative organisations, ranging from a small proportion of poultry and vegetables up to 75 per cent. of American grown citrus fruits, 90 per cent. of dried fruits, 70 per cent. of tobacco, while they also deal with 25 per cent. of milk and milk products, and 20 per cent. of cotton. In all about 1,200,000 farmers belong to these commodity organisations, the cotton associations of the Southern States—to take an example—having a membership of more than 200,000. In regard to the latter it has been stated that every member who marketed his crop last year through a cotton association received at least $20 per bale more than the non-members received for the same grade and quality of cotton.

In conclusion, two quotations may be given from a book‡ on which much of the information in this article is based :—

"Intelligent merchandising of farm commodities through co-operative associations leads finally to a stabilised agriculture, in which fluctuations in prices are minimised, risks of operations greatly reduced, and a premium placed upon the farmer's ability as a producer."

"The farmer retains his individualism as a producer, but he puts group selling to work as his sales manager. Neighbour joins with neighbour, they pool their product, each man has one vote in the control, and they share and share alike in a new system of economic justice for agriculture."—
JOURN OF MIN. OF AGRIC., Vol. XXX., No. 10.

---

* Report to the President on the Wheat situaiton, by EUGENE MEYER, Jnr., and FRANK W. MONDELL.

† See the Statist article on "The Growth of American Co operative Marketing." 24th November, 1923, p. 710.

‡ "Co-operative Marketing: The Golden Rule in Agriculture," by HERMAN STEEN, American Farm Bureau Federation Library; DOUBLEDAY, PAGE & Co.

GENERAL.

AGRICULTURAL COMPETITIONS IN THE SOUTHERN DIVISION.

GALLE DISTRICT.

CO-OPERATIVE SOCIETIES.

The following prizes will be offered for competition among the members of the Co operative Societies in the Galle District during the Yala season 1924, *i.e.* :—

Akmimana Society	Illupitiya Society
Akuretiya Society	Nagoda Society
Bentota Society	Talpe Society
Elpitiya Society	Unanwitiya Society
Galle Wellaboda Pattu Society	Udugama Society
Ganegama Society	Yatalamatta Society
Galle Gangaboda Pattu Society	Welitara-Kosgoda Society
Hinidum Pattu Society	Galle Catholics' Society
Heenatigala Society	Batapola Society

1. For the best plot of Paddy :—

	Rs.
First Prize	75
Second Prize	50
Third Prize	25

2. Vegetable Garden Competition :—

(*a*) For the best miscellaneous Vegetable Garden :—

	Rs.
First Prize	30
Second Prize	25

(*b*) For the best plot of Chillies :—

First Prize	30
Second Prize	20

(*c*) For the best plot of Snake Gourds :—

First Prize	30
Second Prize	20

(*d*) For the best plot of Brinjals :—

First Prize	30
Second Prize	20

(*e*) For the best plot of Beans :—

First Prize	30
Second Prize	20

(*f*) For the best plot of Bandakka :—

First Prize	30
Second Prize	20

3. Secretary's Prize :—

A prize of Rs. 10 will be given to the Secretary obtaining the largest number of entries for all the competitions.

The Competitions will be subject to the following conditions :—

1. The extent of the land entered for the best plot of paddy competition must not be less than one acre, and for the vegetable gardens competition not less than ¼ of an acre.

2. Entries for the competitions will be restricted to the members of Co-operative Societies.

3. Competitors must give their names to the Secretary of their Society on or before May 31, 1924.

4. The Secretary of each Society will then send the list of entries to the Divisional Agricultural Officer, Southern Division, Galle.

5. The following is a list of points on which the plots will be judged:—

PADDY PLOT.

Yield	20
Cultivation	15
Manuring	15
Selection of seed	15
Freedom of weeds and paddy fly	15
Levelling	10
State of bunds and attention to irrigation and drainage	10
	100

VEGETABLE PLOTS.

Vegetables grown, varieties ...	50
General arrangement of the garden	10
Cleanliness and draining ...	10
System of rotation and manuring ...	10
Tilth of the soil	10
Evidence of marked originality ...	10
	100

6. The final judging will be carried out by officers of the Agricultural Department.

7. The results, with distribution of prizes, will be made known at a special meeting of the Societies to be convened later.

MATARA DISTRICT.

CO-OPERATIVE SOCIETIES.

The following prizes will be offered for competition among the members of the Co-operative Societies in the Matara District during the

Yala season, 1924 :—

TRANSPLANTED PADDY.

For the best transplanted plot.

Weligam Korale :—Akuressa, Kamurugamuwa, Hallala, Telijjawila, and Weligama Societies.

			Rs.
First Prize	...	...	50
Second Prize	...	...	30
Third Prize	...	...	15

Morawak Korale .—Deniyaya, Urubokka, Mawarala, and Morawaka Societies.

			Rs.
First Prize	...	...	50
Second Prize	...	...	30
Third Prize	...	...	15

Kandaboda Pattu :—Ranchagoda, Kandaboda Pattu Societies.

			Rs.
First Prize	...	...	50
Second Prize	...	...	30
Third Prize	...	...	15

VEGETABLE GARDEN.

For the best Miscellaneous Vegetable Garden.

Wellaboda Pattu :—Walasgala and Wellaboda Societies.

			Rs.
First Prize	...	...	50
Second Prize	...	...	30
Third Prize	...	...	15

Gangaboda Pattu :—Gangaboda Pattu, Witiyala, and Yatiyana Societies.

			Rs.
First Prize	...	...	50
Second Prize	...	...	30
Third Prize	..	...	15

Four Gravets :—Madihe, Matara Four Gravets, and Matara Wesleyan Mission Societies.

			Rs.
First Prize	...	...	50
Second Prize	...	...	30
Third Prize	...	...	15

Secretary's Prize :—

A prize of Rs. 5 will be given to the Secretary obtaining the largest number of entries for competition in each respective korale or pattu.

The competitions will be subject to the following conditions :—

1. The extent of the land entered for the best plot of paddy competition must not be less than one acre and for the vegetable garden competition not less than ½ of an acre.

2. Entries for the competitions will be restricted to the members of Co-operative Societies,

3. Competitors must give their names to the Secretary of their Society on or before June 30, 1924.

4. The Secretary of each Society will then send the list of entries to the Divisional Agricultural Officer, Southern Division, Galle.

5. The following is a list of points on which the plots will be judged :—

PADDY PLOT.

Yield	20
Cultivation	15
Manuring	15
Selection of seed	15
Freedom of weeds and paddy fly...	15
Levelling	10
State of bunds and attention to irrigation and drainage	10
	100

VEGETABLE PLOTS.

Vegetables grown, varieties ...	50
General arrangement of the garden	10
Cleanliness and draining ...	10
System of rotation and manuring ...	10
Tilth of the soil	10
Evidence of marked originality ...	10
	100

6. The final judging will be carried out by officers of the Agricultural Department.

7. The results, with distribution of prizes, will be made known at a special meeting of the Societies to be convened later.

KALUTARA DISTRICT

CO-OPERATIVE SOCIETIES.

The following prizes will be offered for competition among the members of the Co-operative Societies in Pasdun korale West (Kalutara district), during the Yala season 1924, *i.e.* :

Dodangoda Society	Meegamabadda Society
Ittapana Society	Namuttuduwa Society
Matugama Society	Welipenna Society

1. For the best plot of Paddy :—

	Rs.
First Prize	75
Second Prize	50
Third Prize	25

2. Vegetable Garden Competition :—

(*a*) For the best miscellaneous Vegetable Garden :—

	Rs.
First Prize	30
Second Prize	20

(*b*) For the best plot of Chillies :—

First Prize	30
Second Prize	20

(*c*) For the best plot of Snake Gourds:—

First Prize	30
Second Prize	20

(*d*) For the best plot of Brinjals :—

First Prize	30
Second Prize	20

3. Secretary's Prize :—

A prize of Rs. 10 will be given to the Secretary obtaining the largest number of entries for all the competitions.

The competitions will be subject to the following conditions :—

1. The extent of the land entered for the best plot of paddy competition must not be less than one acre, and for the vegetable garden competition not less than ¼ of an acre.

2. Entries for the competition will be restricted to the members of Co-operative Societies.

3. Competitors must give their names to the Secretary of their Society on or before May 31, 1924.

4. The Secretary of each Society will then send the list of entries to the Divisional Agricultural Officer, Southern Division, Galle.

5. The following is a list of points on which the plots will be judged :—

PADDY PLOT

Yield	20
Cultivation	15
Manuring	15
Selection of Seed	15
Freedom of weeds and paddy fly ...	15
Levelling	10
State of bunds and attention to irrigation and drainage	10
	100

VEGETABLE PLOT

Vegetables grown, varieties ...	50
General arrangement of the garden ...	10
Cleanliness and drainage ...	10
System of rotation and manuring ...	10
Tilth of the soil	10
Evidence of marked originality ...	10
	100

6. The final judging will be carried out by officers of the Agricultural Department.

7. The results, with distribution of prizes, will be made known at a special meeting of the Societies to be convened later.

HAMBANTOTA DISTRICT.

The following competitions will take place in the Hambantota District during 1924 :—

MAGAM PATTU.

Best plot of paddy (Yala 1924) grown on lands under the Kirindi-oya Left Bank and Kirindi-oya Right Bank Scheme.

			Rs.
First Prize	...	...	25
Second Prize	...	...	15
Third Prize		...	10

Entries for this competition will close on June 30, 1924, and judging will be carried out during July and August, 1924.

This competition will be conducted in accordance with the following rules :—

1. The extent of land entered for competition shall not be less than 1 acre.

2. The following is a list of points on which the paddy plots will be judged :—

1.	Seed selected plots	...	50
2.	Estimated yield ...	...	50
3.	Freedom from weeds	...	20
4.	Uniformity of growth	...	10
5.	Freedom from pests and diseases	...	10
6.	State of bunds and irrigation channels		10
			150

3. Competitors may give their names to the Mudaliyar of the pattu or to the Agricultural Officer, Ambalantota.

4. Judging will be carried out by officers of the Agricultural Department, Southern Division.

EAST GIRUWA PATTU.

Cotton Competition.

Prizes of Rs. 20, Rs. 10 and Rs. 5 will be awarded to the best three cotton gardens in each of the following Vidane Aratchies' Divisions, viz.: Modaragampalata, Pahalawalakada, Ihalawalakada, Paranagampalata, and Wewagampalata:—

1. Each garden entered for competition must not be less than ¼ of an acre in extent. Entries will close on February 28, 1924.

2. Competitors will give their names to the Mudaliyar of the pattu or to the Agricultural Officer, Ambalantota.

3. Judging will take place in March, 1924, and will be carried out by officers of the Agricultural Department, Southern Division.

4. Final decision as to the award of prizes will be arrived at by the Food Production Committee, Hambantota District, which will consider the reports submitted and if they deem it necessary, depute a judging Committee.

5. The following is a list of points on which gardens will be judged :—

1.	Estimated Yield ...	...	40
2.	Cleanliness (freedom from weeds)	...	20
3.	Spacing ...	....	10
4.	Freedom from pests and diseases	...	20
5.	Tilth of the soil ...	..	10
			100

KURAKKAN EXPERIMENTS AT JAFFNA.

The following is an extract from the Monthly Report of the Divisional Agricultural Officer, Northern Division, for December, 1923, on experiments with kurakkan carried out at the Experiment Station, Jaffna.

KURAKKAN VARIETY TEST.

The results of the 11 varieties of kurakkan are shown in the following statement :—

YIELD PER ACRE

Variety	Source	1st Series			2nd Series			3rd Series			Average for 1920—21			Average for 1921—22			Average for 1922—23		
		Grain		Straw	Grain		Straw	Grain		Straw	Grain		Straw	Grain		Straw	Grain		Straw
		M.	lb.	lb.	M.	lb.	lb.	M.	lb.	lb.	M.	lb.	lb.	M.	lb.	lb.	M.	lb.	b.
H. 2. Green open -	Mysore	396	792	7,260	231	462	5,280	132	264	8,778	165	330	6,072	440	880	4,996	253	506	7,106
Bellary Ragi -	Madras	264	528	5,280	462	924	8,646	462	924	13,200	319	638	7,436	440	880	4,821	396	792	9,042
H. 22. Violet open -	Mysore	198	396	9,240	396	792	8,184	231	462	10,164	165	330	6,468	462	924	4,224	275	550	9,196
H. 42. Green Mutant-	,,	198	396	8,184	198	396	6,864	264	528	7,788	99	198	6,745	396	792	3,916	220	440	7,612
H. 41. Violet Mutant-	,,	330	660	8,316	33	66	4,884	132	264	8,712	110	220	6,336	396	792	5,544	165	330	7,304
H. 13. Green open -	,,	330	660	10,296	396	792	10,824	297	594	13,134	330	660	12,892	484	968	4,763	341	682	11,418
Jadasanga Ragi -	,,	264	528	7,128	132	264	7,524	330	660	10,098	330	660	8,272	418	836	4,664	242	484	8,250
H. 3. Green open -	,,	231	462	6,996	396	792	7,524	330	660	12,408	242	484	7,005	484	968	4,092	319	638	8,976
H. 7. Green open -	,,	396	792	9,240	198	396	6,600	165	330	13,464	132	264	6,160	528	1056	4,092	253	506	9,768
Local B. -	,,	198	396	3,828	132	264	4,620	264	528	7,656	561	1122	8.800	418	836	4,532	198	396	5,368
Local W. -	,,	396	792	5,016	462	924	7,854	462	924	8,976	561	1122	7,566	418	836	4,532	440	880	7,282

KURAKKAN CULTIVATION EXPERIMENT.

In this experiment two plots of equal size were laid out into beds and ridges and the seedlings were planted to see which method would give more yield. Care was taken in laying out the ridges to allow even distribution of water along the furrows and in seeing that the seedlings are planted sufficiently closely along the ridges. This is the first year of the trial tentatively and the results so far show that the ridge system will give as good or better crop with considerable saving in irrigation.

	Yield per acre	
	Grain	Straw (Wet weight)
	lb.	lb.
Ridges	448	13,328
Beds	320	12,160

KURRAKKAN—TOBACCO MANURIAL PLOTS.

The results of the kurakkan planted in field No. 7 to test the residual effect of the various manures applied to the previous tobacco crop is given below :—

Treatment	Yield per acre 1st series Grain Measures	Yield per acre 2nd series Grain Measures	Yield per acre 3rd series Grain Measures
1. Cattle penned at 1,200 per acre and green leaf at 12 cart-loads per acre	528	512	520
2. Cattle manure at 40 cart-loads per acre and 12 cart-loads green leaf per acre ...	528	608	568
3. Green leaf at 12 cart-loads per acre and sheep penned at 4,000 per acre ...	640	496	568
4. Sunnhemp green manured and 8 cart-loads green leaf and artificials	656	752	704
5. Green leaf at 12 cart-loads per acre and artificials	624	672	648
6. Green leaf at 12 cart-loads per acre and fish guano to supply equal quantities of nitrogen as 40 cart-loads of cattle manure per acre	480	448	464

A FEW OBSERVATIONS ON PADDY *(ORYZA SATIVA)* CROSSING.*

S. G. SHARNGAPANI, B. Ag.

Offg. Economic Botanist, Bengal.

The paddy spikelet or flower offers some difficulties in successful crossing. Experience showed us that special methods must be employed in successfully crossing it. As a result we gradually evolved a method which is now nearly cent. per cent. successful. To understand the difficulties and to learn how they have been overcome, one must first learn the mechanism of the paddy flower.

The paddy flower is composed of two short empty outer glumes usually not more than one-third the length of the inner glumes. They are of no account in paddy crossing, for they neither help nor retard the crossing in any way.

The inner glumes are generally two in number and though not differing from each other in size and texture, one of them (the third as it is called) is five-nerved and bears at its apex an awn in all awned varieties of paddy. The other (fourth glume) is three-nerved and when removed bears away with it the ovary. the stigmas and a few of the stamens. The two inner glumes between themselves enclose the paddy grain. Inside the inner glumes are two broadly oval, small, thick, fleshy bodies, the lodicules. They play an important part in the opening of paddy flowers.

The stamens are six in number. All are well developed fertile and functioning. In a mature spikelet held to light, they are seen to occupy about half the length of the entire spikelet.

The ovary is unicellular†, a little longer than broad, smooth. and bears at its apex two styles with feathery stigmas.

The mistake that one is likely to make in crossing paddy is to consider the glumes as functioning the same as they do in the case of wheat. In crossing wheat the glumes are usually snipped off with a pair of fine scissors before emasculation. The same procedure cannot be followed in the case of paddy, because the glumes are delicate, protective in function and form a part and parcel of the mature seed. If they are injured in any way likely to set up withering, the seed does not set.

Paddy anthers usually burst just a little before the flower opens. We found by actual experience that emasculation must be done at the latest two hours before the flower opens. The two glumes are very gently pulled apart with fingers—no forceps should be used—and the stamens removed with a pair of fine bent forceps. About two hours later when paddy flowers begin to open, the emasculated flowers are pollinated and the glumes are closed and tied up with a piece of fine silken thread. The tying helps to keep the glumes in their natural position. If the glumes are not tied up, they do not close properly and the percentage of successful crosses diminishes greatly. The tying up also does the work of bagging and no further bagging is necessary.

---

* Paper read at the Indian Science Congress, Lucknow, 1923.

† In the double-rice paddy, however, the ovary may be bi-, tri-, or quadri-cellular, the number of styles then becoming double the number of cells present in the ovary.

The time at which the flowers open differs with the time of the year when the paddy plant flowers. For instance *aus* or early paddy, which is sown in April-May and flowers in July-August, opens at about 7 a.m., while the *sail* or transplanted paddy which flowers in October opens at about 9 a.m. Weather conditions at the time of flowering affect a good deal the time of opening, sunshine hastening the process and clouds and rain retarding. It has been found possible to cross the *aus* with the *aman* or *sail* paddy and the *aman* again with the wild paddy, and some of the resultant crosses are yielding very interesting results. If it is intended to cross *sail* paddy with *aus* paddy under ordinary field conditions, it is more convenient to grow the *sail* paddy in its proper seasons, and to grow the *aus* paddy out of its season, for the *aus* can be made to grow and flower during the *aman* season while the *sail* paddy cannot be made to flower during the *aus* season. In crossing with the wild paddy it is important that the *sail* paddy should be used as the female parent and the wild paddy as the male, because the wild paddy spikelets shed before the grains mature. If the wild paddy is used as the female parent the crosses are shed before they are ripe, and are thus lost.—AGRIC. JOURN. OF INDIA, VOL. XIX., PT. 1.

PADDY TRANSPLANTING COMPETITIONS IN UVA.

E. W. DIAS BANDARANAIKE,

Senior Agricultural Instructor, Badulla.

During the year 1922-1923, there were a larger number of Competitors for the paddy transplanting competitions than in previous years. The fields entered for competitions were visited by the Agricultural Instructor, Bibile and myself with the Ratemahatmayas of the various Divisions. The transplanted fields in the Udu Kinda Division were found to be very good when compared with those of other divisions due to the variety of paddy used being 6 months' type.

MUDALIYAR JAINUDEEN who always takes a great deal of interest in agriculture offered a prize for the best *asweddumised* land in Wellasa, but as there were no entries in that class, the prize was offered to the third best transplanted field in Wellasa Division.

As there were no entries from Wellawaya Division, these two prizes of Rs. 15/- and Rs. 10/- respectively were offered to the Wellasa Division for the two best green manured fields.

The following are the results of the Competitions :—

PADDY TRANSPLANTING COMPETITIONS.

Name of Division	Prize won	Name of winner	Value of Prize	Extent transplanted	Manure applied	Marks obtained Total 100
1. Wellassa	1st	M. P. Fernando	Rs. 20 00	1 ammunum	Farmyard and Green Manure	78
	2nd	A. B. Galagoda	Rs. 10 00	6 pelas	do	62
	3rd	A. M. Punchi Banda (Special prize)	Rs. 10 00	2 ,,	do	60
2. Bintenne	1st	M. P. Mohammed	Rs. 20 00	1 ammunum	do	65
	2nd	K. Tissahamy	Rs. 10 00	do	Farmyard manure	58
3. Yatikinda	1st	G. Manikrala	Rs. 20 00	7 pelas	Field Rabbed and Farmyard manure	75
	2nd	H. Heen Banda	Rs. 10 00	1 ammunum	Farmyard manure	69
	3rd	I. Sudu Banda	Rs. 10 00	7 pelas	Green manure	64
4. Udukinda	1st	D. Kiri Banda	Rs. 20 00	6 pelas	Field rabbed	68
	2nd	D. Punchi Banda	Rs. 10 00	3 ,,	do	59
5. Wiyaluwa	1st	D. B. Marathnis	Rs. 20 00	1 ammunum	Farmyard and Green manure	72
6. Buttala	1st	K. M. Muthu Banda	Rs. 15 00	3 pelas	Green manure	65
	2nd	P. B. Jayasinghe	Rs. 10 00	2 ,,	do	61

BEST GREEN MANURED FIELD.

Division	Prize won	Name of Winner	Value of Prize	Extent	Marks obtained Total 50
Wellassa	1st	W. M. Kalu Banda	Rs. 15 00	5 pelas	41
	2nd	A. Kurabba	Rs. 10 00	5 pelas	36

TRANSPLANTING LARGE TREES.

H. B. PENHALLOW.

Four date palms and a coconut, all mature trees, about twelve years old, were successfully transplanted this last August on the premises to be occupied by the new office of the Wailuku Sugar Company. All the trees were growing on the area to be occupied by the building, and as they were desirable trees, rather than cut them down, it was decided to remove them bodily and transplant them in a suitable place, which was selected in the vicinity. A trench was dug around each tree, about four feet deep, leaving a mass of earth and roots approximately eight feet in diameter on each tree. This was cut under toward the centre making it bowl shape, and was wrapped around with chicken wire netting suitably lashed in place in order to keep the earth in a compact body. The bottom roots were cut off by drawing a loop wire cable under each tree at the bottom of the trench. The side toward which the tree was to be moved was dug out to the desired slope, the tree canted over to allow skids to be placed under it, returned to an upright position and hauled out by block and tackle, with the aid of a tractor. Also by this means the trees were taken to the new location (some fifty feet or more away) and placed in the holes prepared for them. The chicken wire was left in place in order to keep the root mass intact and less disturbed, as the new roots can readily seek an outlet through the mesh. As each tree weighed in the neighbourhood of from ten to fifteen tons, considerable care was required in handling them. It took several days to transplant the trees. Apparently it was successfully done, as two months later all are thriving.

Apparently many trees are needlessly sacrificed which could be transplanted to good advantage with but little cost and effort compared to their value. Before cutting down some rare tree, give this a thought.—HAWAIIAN FORESTER & AGRICULTURIST. Vol. XX., No. 4.

MARKET RATES.

MARKET RATES FOR SOME TROPICAL PRODUCTS.

(FROM LEWIS & PEAT'S, Ltd., MONTHLY PRICES CURRENT OF 4th JANUARY, 1924).

GOODS	QUALITY	PRICE	PER	Pkgs.	POSITION	MARKET
COPRA—						
" ...	Ceylon ...	£ 32	ton	Bags	C.i.f. U.K.	Firm
" ...	Malabar ...	Nominal	"	"	" "	"
	Straits [F.M.S.] ..	£ 30/10	"	"	" "	"
OILS—						
Coconut Oil ...	Ceylon ...	47/	cwt.	Casks	" "	Quiet
" ..	Cochin ...	60/	"	"	" "	"
Palm Oil ...	Lagos ...	£39 5/	ton	"	Spot "	Firm
" ...	Sumatra ...	£39	"	"	" "	"
Palm Kernel Oil ...	Crushed ...	43/6	cwt.	Naked	" "	Firm
PALM KERNELS—	West African ...	£20 17/6	ton	Bags	Ex quay L'pool / Spot U.K.	Firm
SEEDS—						
Castor Seed ...	Bombay ...	£24 5/	ton	Bags	C.i.f U.K.	Fully steady

COLOMBO.

(From Weekly Prices Current published by the Ceylon Chamber of Commerce dated 11th February, 1924).

			Rs. c.	@	Rs. c.
Cinnamon Quills.—(At Buyer's Stores)					
Ordinary assortment (in bales of 100 lb. nett) - -		per lb.	0 55	"	0 61
No. 1 - - - -		"	0 58	"	0 63
No. 2 - - - -		"	0 56	"	0 61
No. 3 - - - -		"	0 54	"	0 57
No. 4 - - - -		"	0 52	"	0 55
Cinnamon Chips.—Maradana (At Buyer's Stores) (in bags of 56 lb. nett) per candy of 560 lb. - -			50 00	"	60 00
Citronella Oil.—(ex Seller's Stores without Packages) - - -		per lb.	1 83	"	1 85
Cacao.—(At Buyer's Stores)					
Estate—Finest - - -		per cwt.	48 00	"	56 00
" Medium - - -		"	38 00	"	51 00
" Common (Black) - - -		"	15 00	"	35 00
Coconut—(Desiccated.) Granulated goods (Delivered at Wharf or Buyer's Stores)					
Medium / Fine					
Assortment 50% / 50% - -		per lb.	0 23¾	"	0 24½
Fibres.—(At Buyer's Stores)					
Coconut Bristle No. 1 - -		per cwt.	12 50	"	14 30
do " 2 - -		"			
Coconut Mattress No. 1 - -		"	2 75	"	3 00
do " 2 - -		"			
Coir Yarn, Kogalla No. 4 to 9 - -		"	12 00	"	21 00
do Colombo " 3 to 7 - -		"	12 00	"	14 00

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 29th FEBRUARY, 1924.

Province, &c.	Disease	No. of Cases up to date since Jan 1st, 1924	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	133	82	26	88	16	3
	Foot-and-mouth disease	3	3	3	—	—	—
	Anthrax	—	—	—	—	—	—
Colombo Municipality	Rinderpest	176	94	19	122	35	—
	Foot-and mouth disease	—	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	—	—	—	—	—	—
Cattle Quarantine Station	Rinderpest	3	3	—	1	2	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	53	31	—	53	—	—
	At 2 cases amongst cattle	—	—	—	—	—	—
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	2	1	—	2	—	—
	Piroplasmosis	3	1	—	—	3	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	—	1	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	—	in Jany.	—	—	—	—
	Foot-and-mouth disease	—		—	—	—	—
	Anthrax	—		—	—	—	—
	Hæmorrhagic Septicæmia	33		—	33	—	—
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	—	1	—	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	240	235	91	144	—	5
	Foot-and-mouth disease	25	—	25	—	—	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest	Free					
	Foot-and-mouth disease						
	Anthrax						
Uva	Rinderpest	Free					
	Foot-and-mouth disease						
	Anthrax						
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	76	—	76	—	—	—
	Anthrax	—	—	—	—	—	—
		—	—	—	—	—	—
		—	—	—	—	—	—

Colombo, 7th March, 1924.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL

FEBRUARY, 1924.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles.	Inches		Inches
Colombo Observatory	81·0	+1·3	78	6·6	Var:	103	2·66	5	+0·93
Puttalam	79 8	+1·2	74	3·0	NNE	149	0·32	1	-0·94
Mannar	80·6	+0·6	76	4·4	NNE	211	0·12	3	-1·15
Jaffna	79·8	+0·8	70	4·2	ENE	91	0·00	0	-1·20
Trincomalee	80·9	+0 6	74	5·1	NE	167	0 67	3	-1·42
Batticaloa	79·6	+1·1	74	5·2	NNE	197	0 38	2	-2·91
Hambantota	80·4	+1·4	78	4·0	ENE	338	0·20	2	-1·25
Galle	79·9	+0·5	82	5·4	Var:	134	7·73	12	+5·03
Ratnapura	82·4	+1·4	74	5·2	—	—	7·51	13	+3·15
Anu'pura	78·4	+0·3	78	4·4	—	—	0·56	2	-0·97
Kurunegala	79·8	-0·2	70	5·8	—	—	1·22	4	-0·35
Kandy	77·4	+1·3	68	4·2	—	—	1·42	6	-0·81
Badulla	71·7	+0·7	82	6·2	—	—	1·99	9	1·03
Diyatalawa	67·0	+1·4	72	6·8	—	—	3·41	9	+1·02
Hakgala	59·2	+1·3	84	6·3	—	—	2·45	13	-0·72
N.' Eliya	58·6	+1·1	79	5·8	—	—	0 38	7	-1·65

The weather on the whole, was fine and bright. Rain when it did occur was mostly of the thunderstorm type and fall towards evening.

Rain of the North-East monsoon type was very limited and naturally heaviest on the North-East slopes of the Hills. Thunderstorm rain was heaviest at medium elevations and to the South West of the Hills. To the North and East there was but little rain while the Peninsula was rainless. Where the rainfall was heaviest it was also slightly above the average, while the remainder of the Island was below normal. Dooroomadella Estate with 17·56 inches on 14 days heads the list of those stations whose returns have so far been received. Kobonella with 15·35 inches is next.

Air Pressure was slightly below normal but its distribution over the Island was very similar to the average.

North-easterly winds predominated and in the South the force was much in excess of the average.

Clouding was slightly more than is usual and probably accounted for the Temperature being above normal. Humidity, at most stations, was below the average but at Nuwara Eliya and Hakgala was decidedly in excess.

J. E. EVANS,
Supdt. Observatory.